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Hitachi F-ZTAT™ Microcomputer

Single Power Supply F-ZTAT™ On-Board Programming

Application Note



ADE-502-055

Rev. 1.0

03/04/03

Hitachi, Ltd.

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Preface

These application notes describe the on-board programming to the flash memory of the single power supply F-ZTAT microcomputers (H8/539FS, H8/3062F/67F · H8/3039F, H8S/2128F/38F/48F · H8S2132F/42F · H8S/2134F/44F · H8S/2357F, SH7050F/51F, SH7044F/45F: as at April 1998) when modifying programs after the microcomputers have been mounted on the PCB. These application notes also describe how to use the on-board programming adapter board and the on-board programming tool (PC I/F software). You are encouraged to refer to these notes when designing your systems to incorporate on-board programming.

Please note that the circuits shown in these application notes are provided for illustrating the process of on-board programming. Their performance is not guaranteed. If you intend to use the circuits shown herein, please be sure to first check that they will operate as intended.

Note: F-ZTAT (Flexible-Zero Turn Around Time) is a trade mark of Hitachi, Ltd.

Contents

Section 1	Overview	1
1.1	Introduction to F-ZTAT Microcomputers	1
1.2	On-Board Programming Modes	2
1.2.1	Boot Mode.....	3
1.2.2	User Program Mode	4
Section 2	F-ZTAT Microcomputer On-Board Programming Tool.....	11
2.1	Adaptor Board	11
2.1.1	Overview of Adapter Board (HS0008EASF3H)	11
2.1.2	Adapter Board Structure.....	12
2.1.3	Adapter Board Operating Sequence	16
2.1.4	Opening and Closing Adapter Board Case	17
2.1.5	Setting the Power Selection Jumper	18
2.1.6	Connecting Adapter Board and User System.....	20
2.1.7	Control Signal Enable/Disable Switch, and “1”/“0” Setting Switch	25
2.1.8	Connecting PC and Adapter Board	27
2.1.9	Turning the Adapter Board ON/OFF	28
2.2	On-board Programming Software	29
2.2.1	Overview of On-board Programming Software	29
2.2.2	On-board Programming Software Transfer Process.....	31
2.2.3	On-board Programming Software Write/Erase Control Program.....	40
Section 3	On-Board Programming.....	53
3.1	Installing the On-Board Programming Software	53
3.2	On-Board Programming Sequence (Boot Mode)	56
3.3	Writing in Boot Mode	57
3.4	On-Board Programming Sequence (User Program Mode).....	66
3.5	Writing in User Program Mode	67
Section 4	Example Use of User System	77
4.1	Example Switching Circuit	77
4.1.1	Example SCI Switching Circuit	77
4.1.2	Example I/O Port Switching Circuit	79

Section 1 Overview

1.1 Introduction to F-ZTAT Microcomputers

The F-ZTAT microcomputers incorporate flash memory, which allows the programs to be written or erased after being mounted on the PCB (after being installed in the end product).

The use of F-ZTAT microcomputers allows programs to be replaced on-board, for parameters to be optimized for each device, and for software to be upgraded and maintenance performed after the product has been shipped.

On-board programming mode has two on-board programming modes (boot mode and user program mode) that can be selected as appropriate (see Section 1.2, “On-Board Programming Modes”). Some PROM programming can be used to write or erase programs.

The single power supply F-ZTAT microcomputers include the following series and models:

H8/500 Series: H8/539F

H8/300H Series: H8/3067F and H8/3039F

H8S/2000 Series: H8S/2128F/38F/48F, H8S2132F/42F, H8S/2134F/44F, H8S/2357F

Super H Series: SH7050F/51F, SH7044F/45F

Table 1.1 shows the features of the F-ZTAT microcomputers.

Table 1.1 F-ZTAT Microcomputer Features

Product name	H8/539F	H8/3062F / 67F	H8/3039F	H8S/2132F, 28F, 38F, 44F, 48F
CPU	H8/500	H8/300H	H8/300H	H8S/2000
Maximum operating frequency	16 MHz(5 V) 10 MHz(3 V)	20 MHz	20 MHz	20 MHz (5 V) 10 MHz (3 V)
Flash memory capacity (KB)	128	128	128	128
Number of flash memory blocks for erasing (Block)	8	8	8	10
Number of rewrites	100 times guaranteed			
Write/erase voltage	FWE (FWP) 5 V \pm 10%			
Write time	100 ms/32 byte (300 μ s/byte) (typ)			
Erase time	100 ms (typ)			
Method of writing/erasing	<ul style="list-style-type: none"> • CPU control method (software control method) • Writing using PROM programmer 			

Product name	H8S/2132F, 42F	H8S/2357F	SH7050F / 51F	SH7044F / 45F
CPU	H8S/2000	H8S/2000	SH-2	SH-2
Maximum operating frequency	20 MHz (5 V) 10 MHz (3 V)	20 MHz (5 V) 10 MHz (3 V)	20 MHz	28.7 MHz(5 V) 16.6 MHz (3.3 V)
Flash memory capacity (KB)	64	128	128/256	256
Number of flash memory blocks for erasing (Block)	10	10	8/12	12
Number of rewrites	100 times guaranteed			
Write/erase voltage	FWE (FWP) 5 V \pm 10%			
Write time	100 ms/32 byte (300 μ s/byte) (typ)			
Erase time	100 ms (typ)			
Method of writing/erasing	<ul style="list-style-type: none"> • CPU control method (software control method) • Writing using PROM programmer 			

1.2 On-Board Programming Modes

There are two on-board programming modes: boot mode, in which writing or erasing is performed in batches, and user program mode, in which the range of writing or erasing can be set independently for each program block.

For details of on-board programming modes, see “On-Board Programming Modes” in the hardware manual for the F-ZTAT microcomputer products.

1.2.1 Boot Mode

(1) Overview of Boot Mode

Boot mode starts the boot program in the F-ZTAT and writes application programs to (or erases them from) the microcomputer's internal flash memory. Figure 1.1 is an overview of boot mode.

The user prepares the application program and write control program (the program that controls the writing to flash memory) on the host machine. The SCI (channel 1, async communications) built into the F-ZTAT microcomputer is used to transfer the program from the host machine.

First, put the F-ZTAT microcomputer in the reset state.

Next, apply a voltage to the FWE (FWP in the case of the SH7044F/45F) pin and mode pin to select boot mode. The boot program then starts when you cancel the reset. The boot program transfers the write control program received from the host machine to the F-ZTAT microcomputer's internal RAM. When the write control program has been received, the whole internal flash memory area is erased.

After the flash memory has been erased, execution branches from the boot program to the write control program transferred to the F-ZTAT microcomputer's internal RAM, and the application program received from the host machine is written to the flash memory.

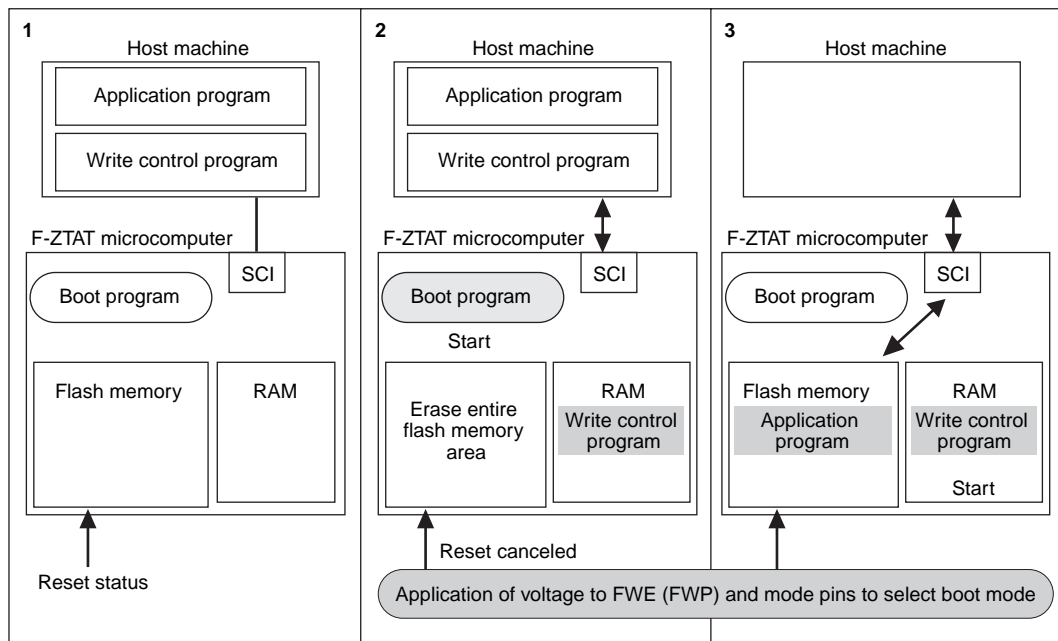


Figure 1.1 Overview of Boot Mode

1.2.2 User Program Mode

(1) Overview of User Program Mode

Before using user program mode you must use boot mode or PROM mode to write the write/erase control program (the program that controls the writing to and erasion of flash memory) and the program (RAM transfer program) for transferring that program to the RAM to the F-ZTAT microcomputer's internal flash memory. Figure 1.2 shows an overview of user program mode.

When using Hitachi's on-board programming tool to transfer application programs from the host machine use the SCI (channel 1, async communications) built into the F-ZTAT microcomputer.

First, put the F-ZTAT microcomputer in the reset state.

Next, apply a voltage to the FWE pin to select user program mode. The RAM transfer proram starts when you cancel the reset, and the write/erase control program is transferred to internal RAM or external RAM and started.

The write/erase control program erases the user-specified block area of flash memory and writes the application program received from the host machine to that area.

Figure 1.3 to 1.9 show the division of flash memory into blocks for each of the F-ZTAT microcomputer products.

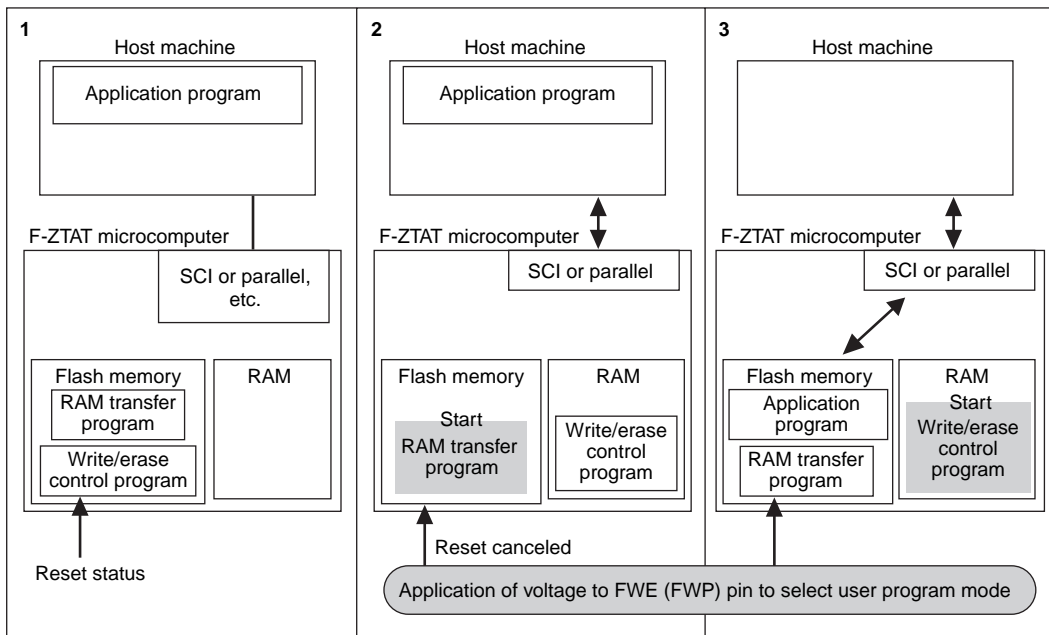


Figure 1.2 Overview of User Program Mode

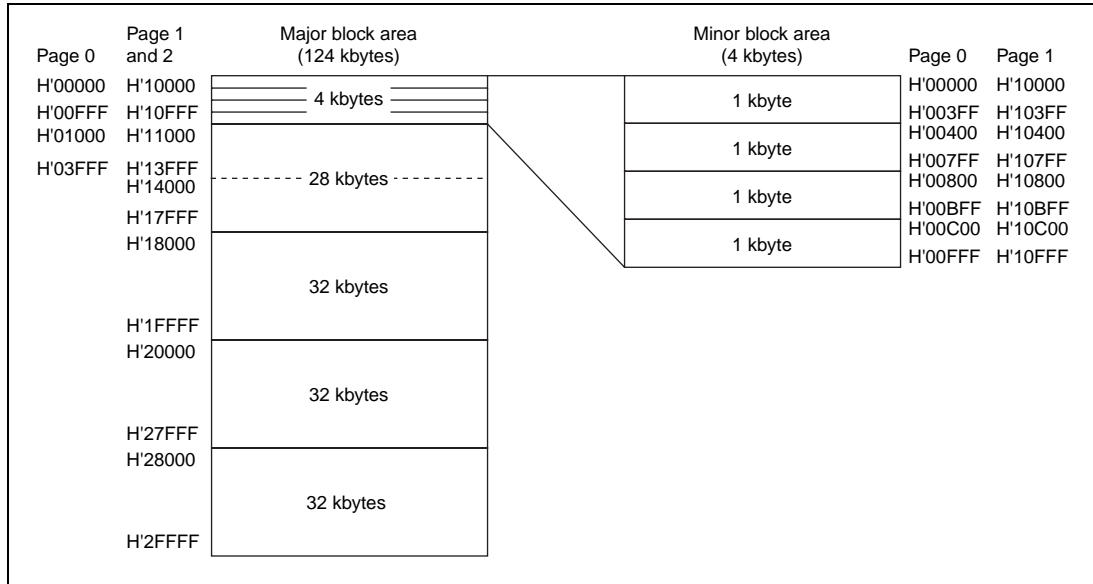


Figure 1.3 H8/539F Internal Flash Memory Block Divisions

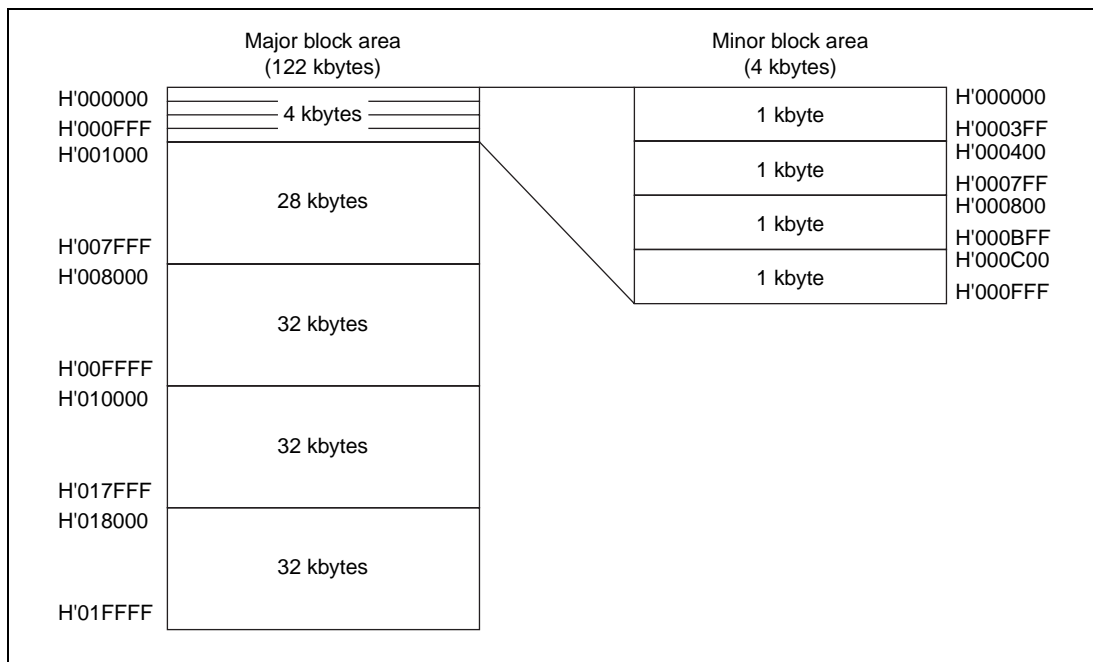


Figure 1.4 H8/3067F/62F Internal Flash Memory Block Divisions

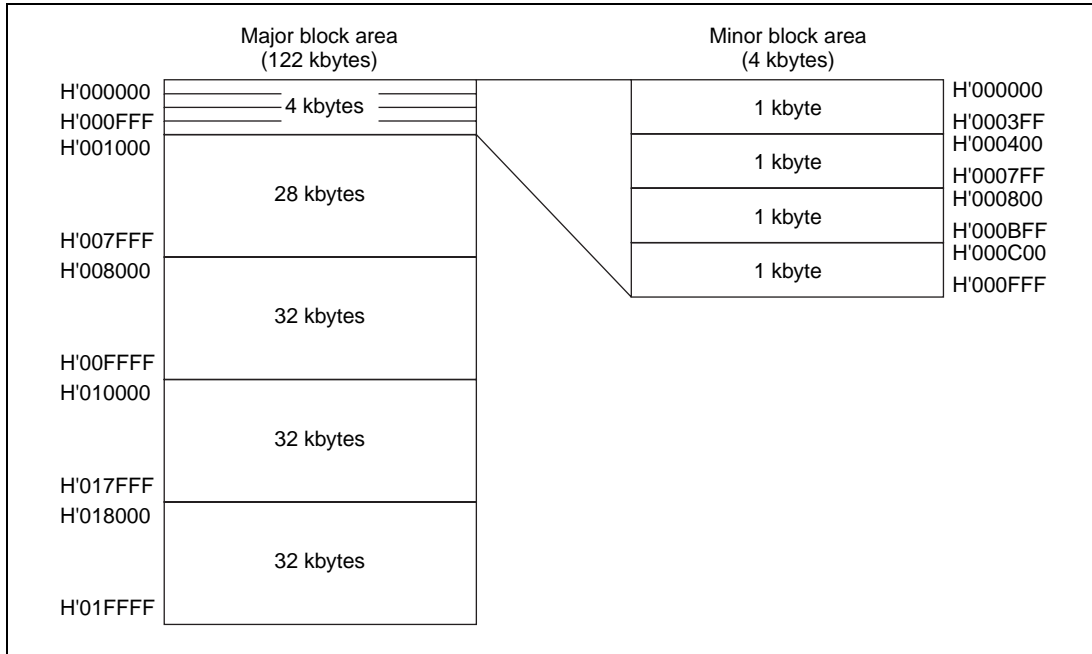


Figure 1.5 H8/3039F Internal Flash Memory Block Divisions

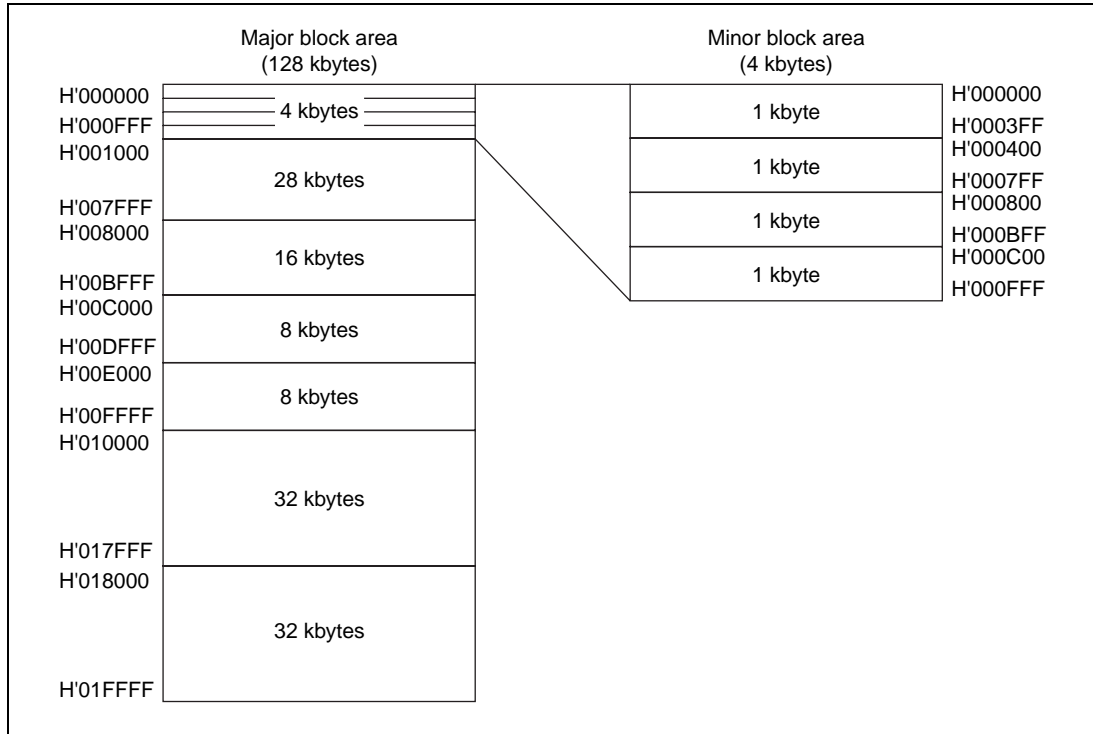


Figure 1.6 H8S/2134F/44F, 2128F/38F/48F, 2357F Internal Flash Memory Block Divisions

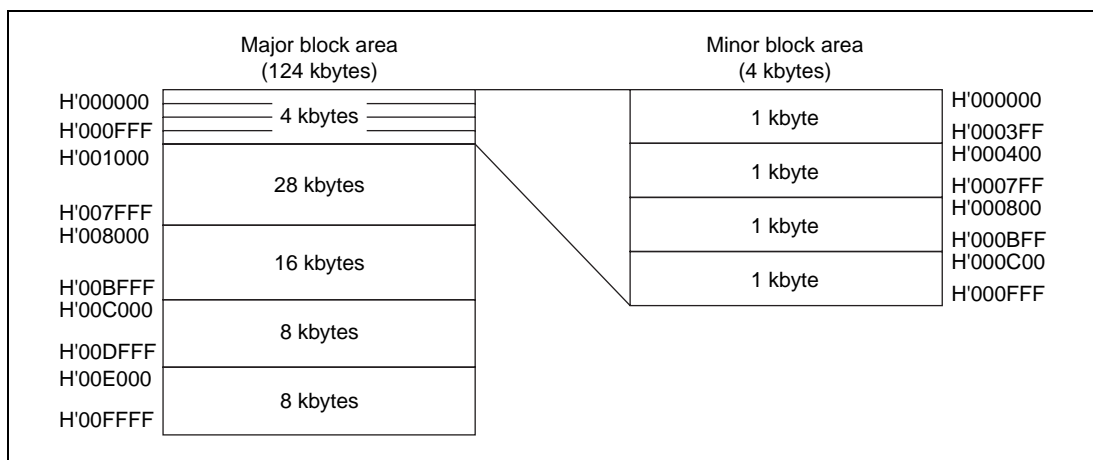


Figure 1.7 H8S/2132F/42F Internal Flash Memory Block Divisions

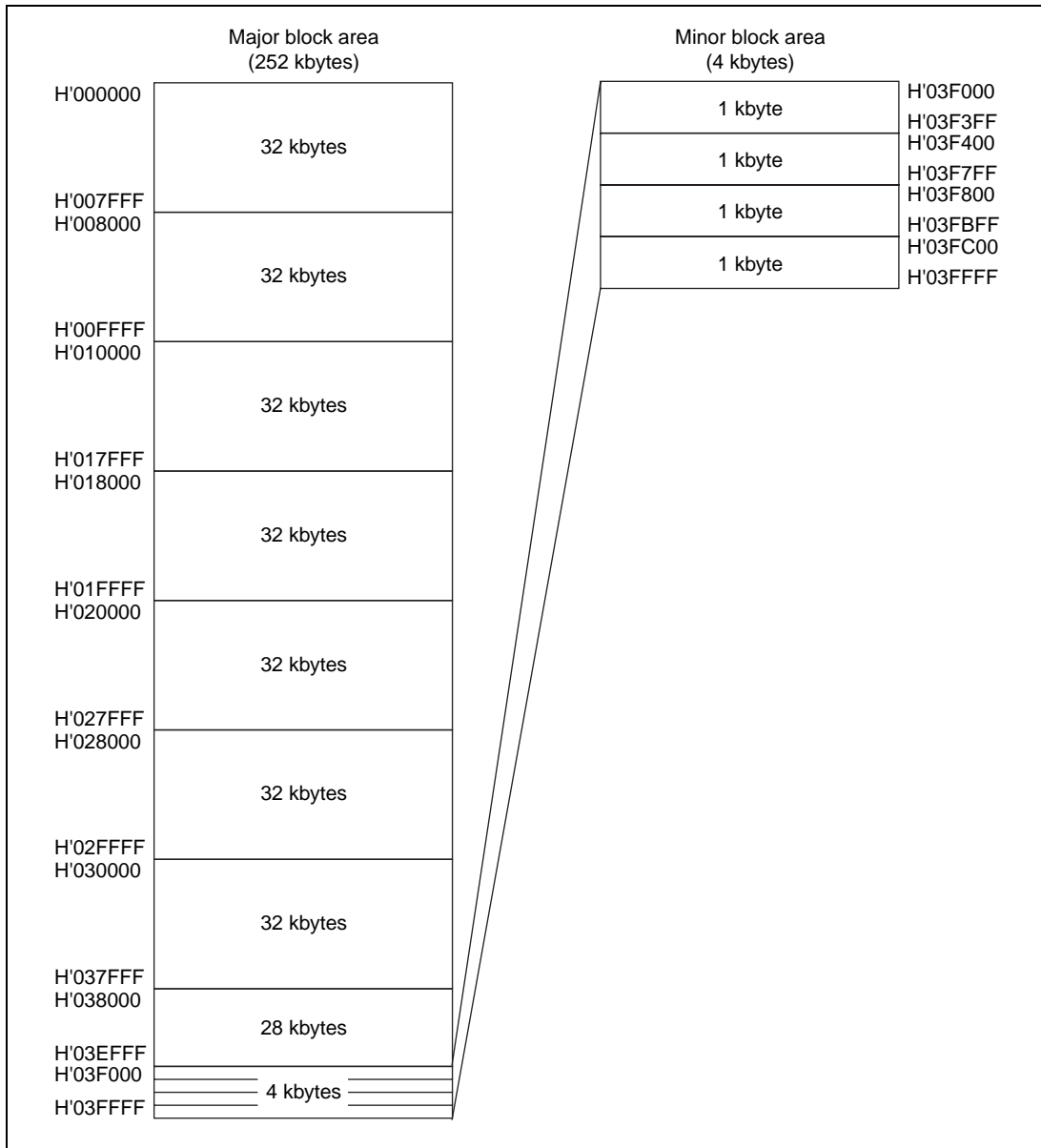


Figure 1.8 SH7044F/45F Internal Flash Memory Block Divisions

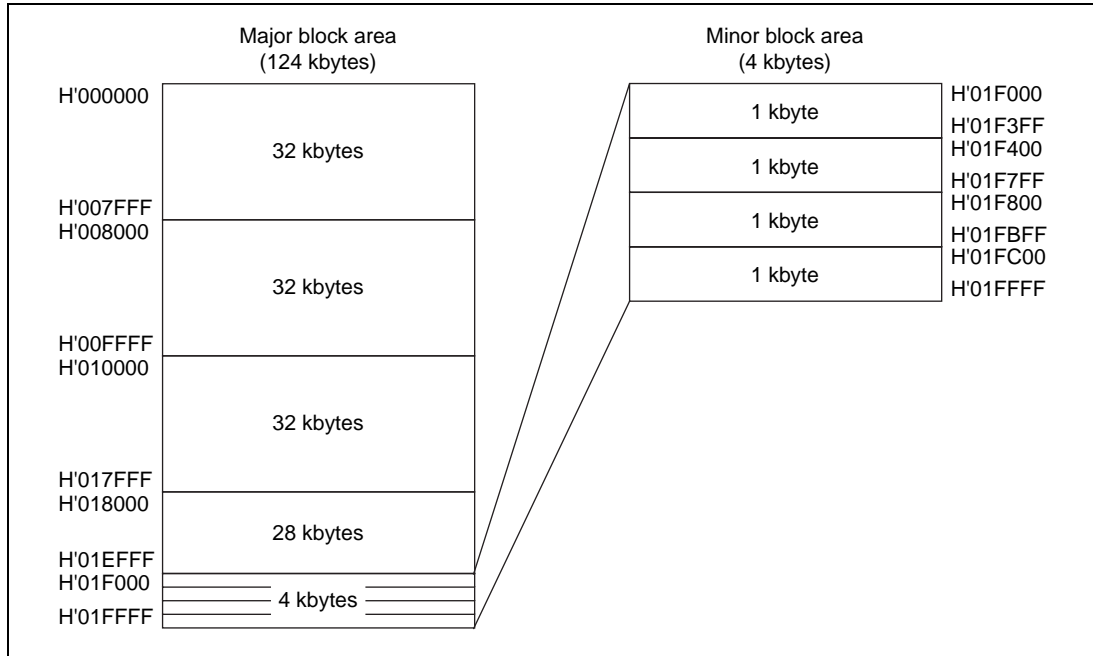


Figure 1.9 SH7050F Internal Flash Memory Block Divisions

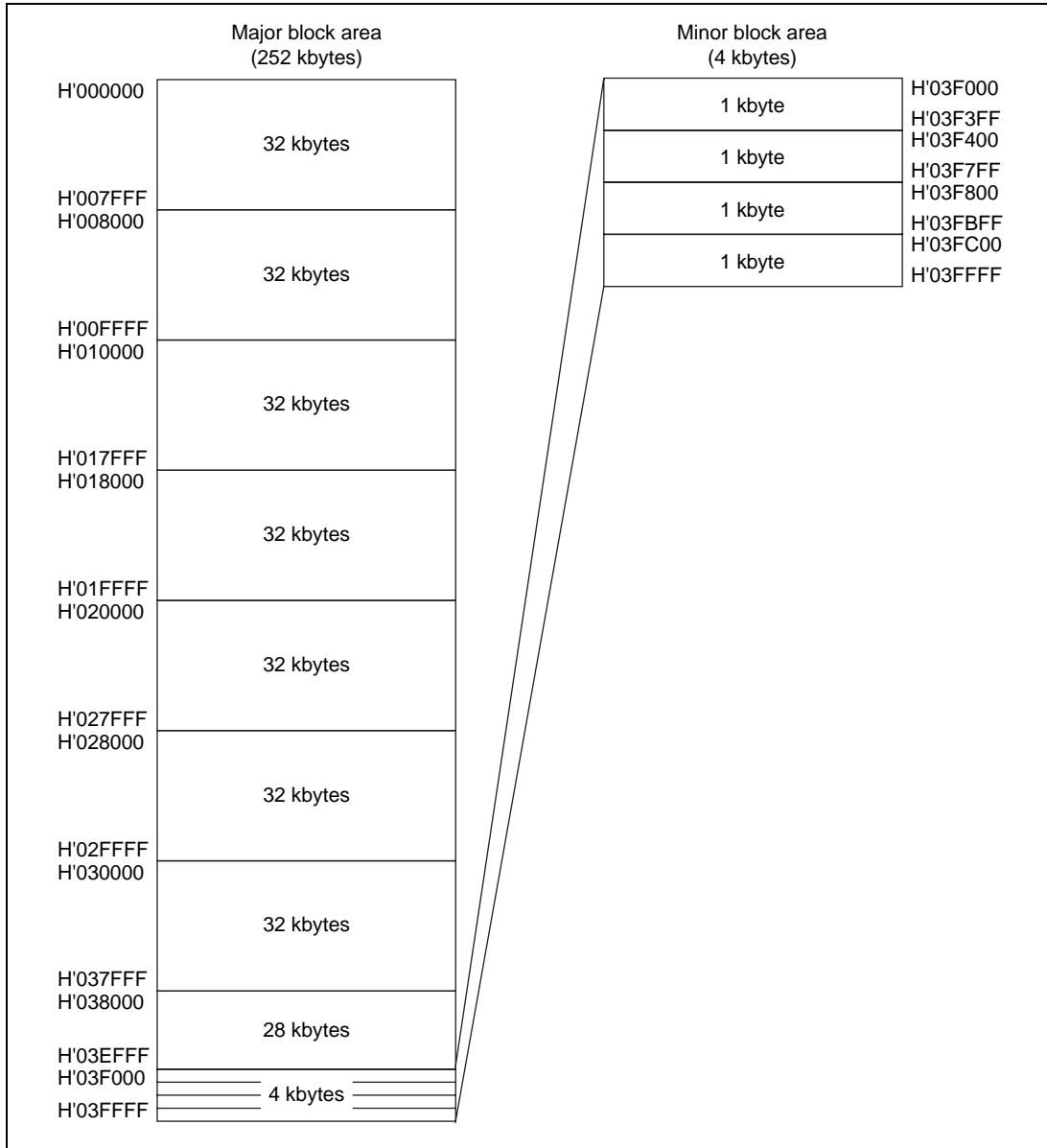


Figure 1.10 SH7051F Internal Flash Memory Block Divisions

Section 2 F-ZTAT Microcomputer

On-Board Programming Tool

2.1 Adapter Board

2.1.1 Overview of Adapter Board (HS0008EASF3H)

The adapter board is hardware that allows the application programs in the F-ZTAT microcomputer to be replaced while mounted on the PCB (in the user's system). By connecting the adapter board between the PC and user system and using the F-ZTAT microcomputer on-board programming software (HS6400FWIW2SF), the application programs of all F-ZTAT microcomputer (single power supply) products can be easily replaced. Also, the adapter board reduces the peripheral circuits required on the user system during the process of on-board programming.

Figure 2.1 shows the adapter board configuration.

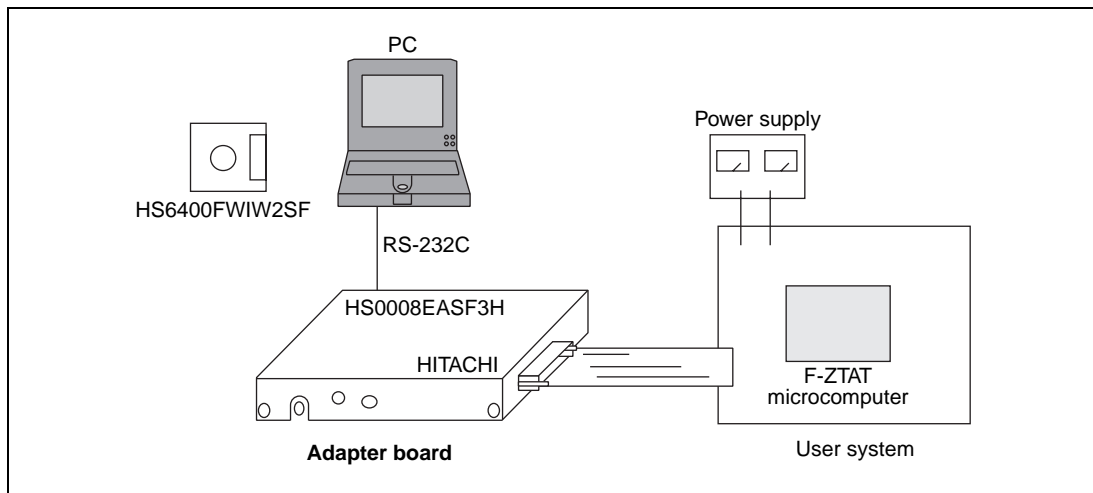


Figure 2.1 Adapter Board System Configuration

2.1.2 Adapter Board Structure

(1) Appearance

Figure 2.2 shows the external appearance of the adapter board. Table 2.1 lists the connectors, switches, and LEDs of the adapter board.

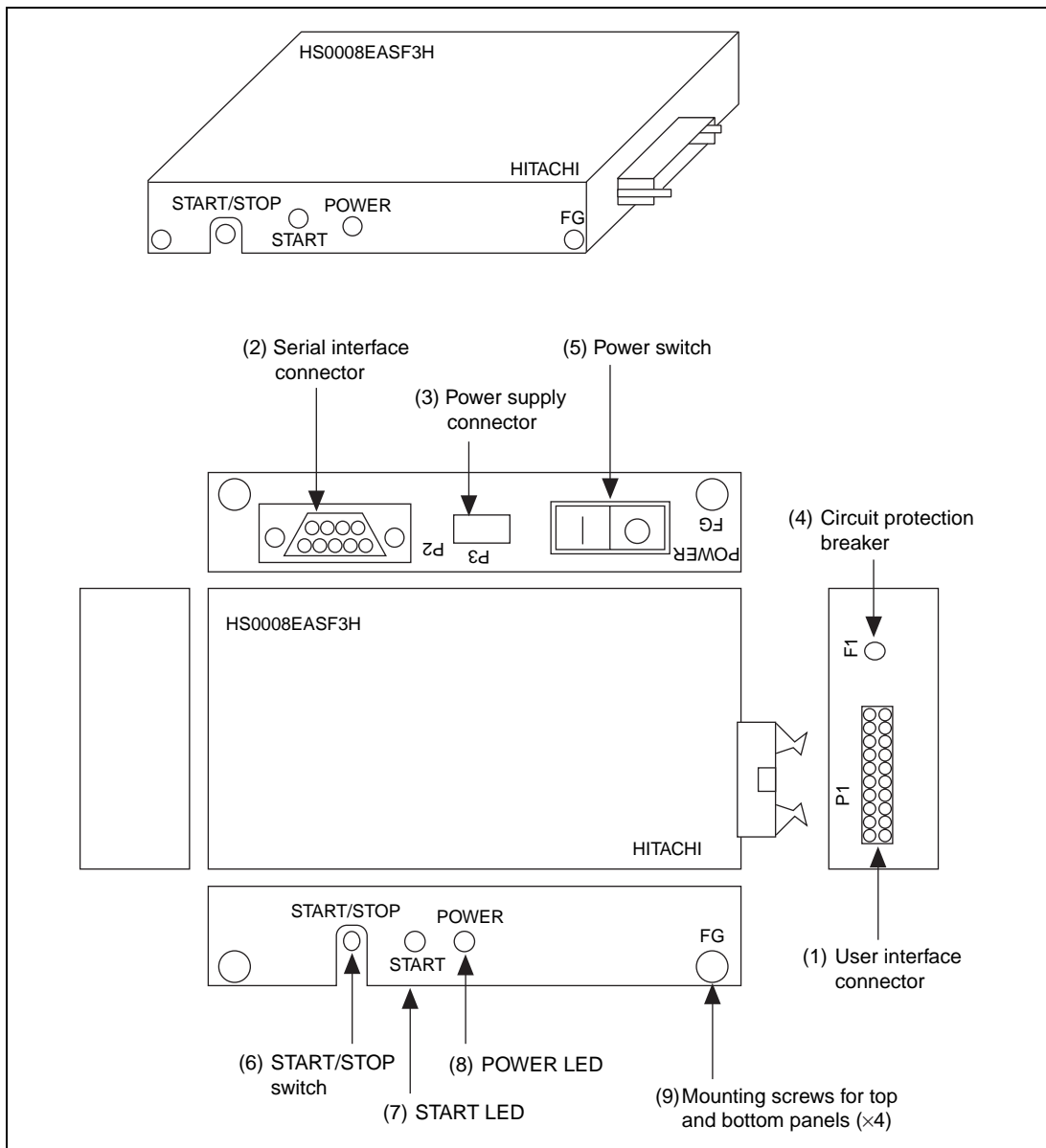


Figure 2.2 Appearance of Adapter Board

Table 2.1 List of Adapter Board Connectors, Switches, and LEDs

No.	Name	Function
(1)	User interface connector (P1)	Connects the adapter board to the user system using the supplied user system connection cable.
(2)	Serial interface connector (P2)	Connects the adapter board and PC using the supplied serial interface cable.
(3)	Power supply connector (P3)	Connects the adapter board and power supply using the supplied power cable.
(4)	Circuit protection breaker	Shuts off the adapter board power supply to protect it from damage in the event of an incorrect power supply connection or overcurrent (1A or more). The circuit breaker can be reset.
(5)	Power switch	Turns the adapter board on and off. Note that the switch is only effective when the power is supplied to the power connector.
(6)	START/STOP switch	Starts and stops write control.
(7)	START LED	Lights when the START/STOP switch is pressed to ON. ON: Starts write control OFF: Ends write control
(8)	POWER LED	Lights when power is supplied to the adapter board.
(9)	Mounting screws for top and bottom panels (×4)	These screws hold the top and bottom panels of the case in place. To set the switches inside the case, remove these screws to open the covers.

(2) View of Interior of Case

Figure 2.3 shows the inside of the adapter board case. Table 2.2 lists the switches and jumpers inside the adapter board case.

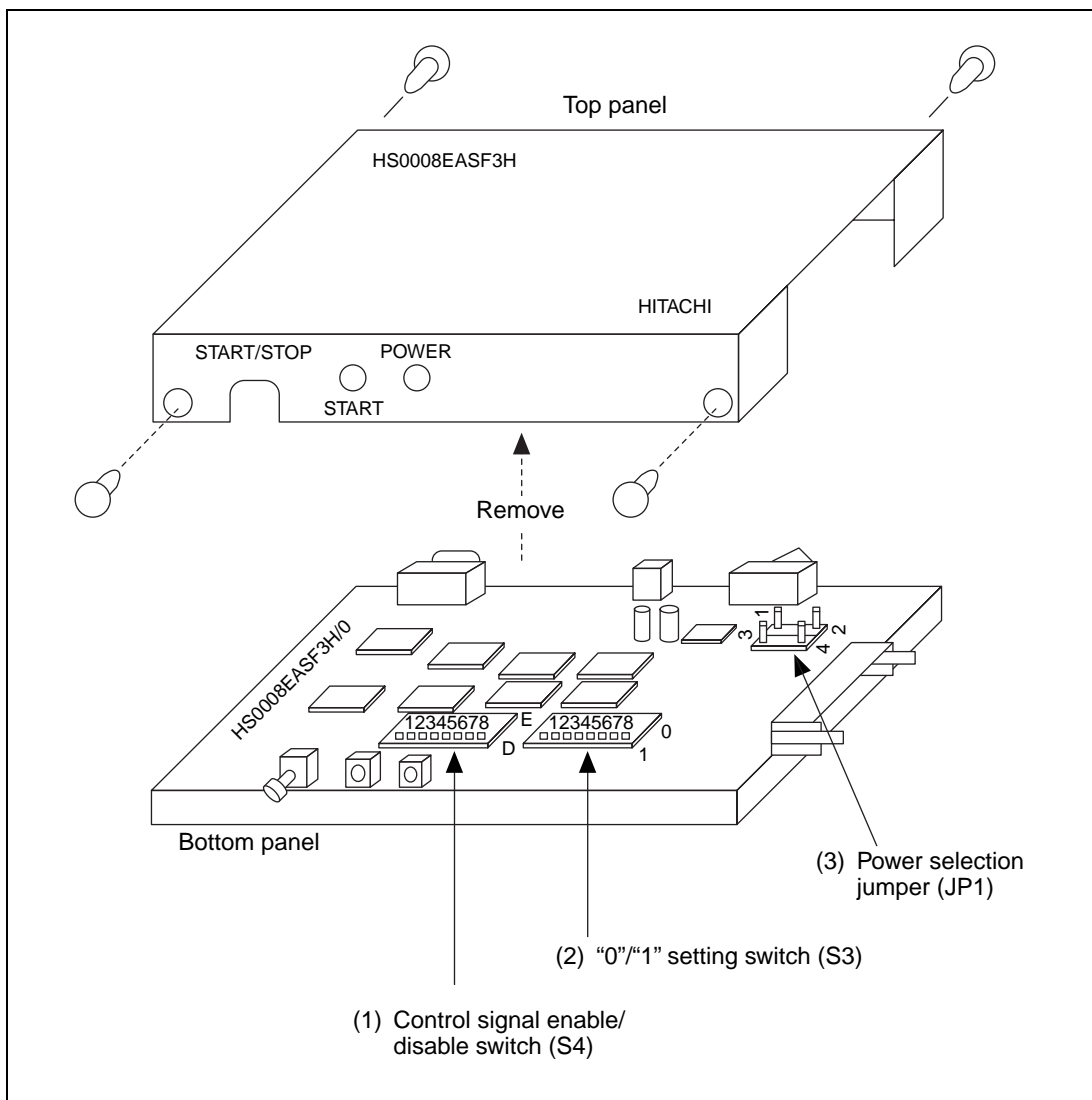


Figure 2.3 View Inside Adapter Board Case

Table 2.2 Adapter Board Internal Switches and Short Connector

No.	Name	Description
(1)	Control signal enable/disable switch (S4)	Sets the write control signal output from the user interface connector ON or OFF.
(2)	"0"/"1" setting switch (S3)	Sets the level ("0" or "1") of the write control signal output from the user interface connector.
(3)	Power selection jumper (JP1)	Sets the method of power supply to the adapter board. The power can be supplied by the user system or via the power supply connector.

2.1.3 Adapter Board Operating Sequence

Figure 2.4 shows an example of the sequence for operating the adapter board. For details of setting up the adapter board and the write operations, see Sections 2.1.4 to 2.1.9 and Section 2.3, “On-Board Programming Method.”

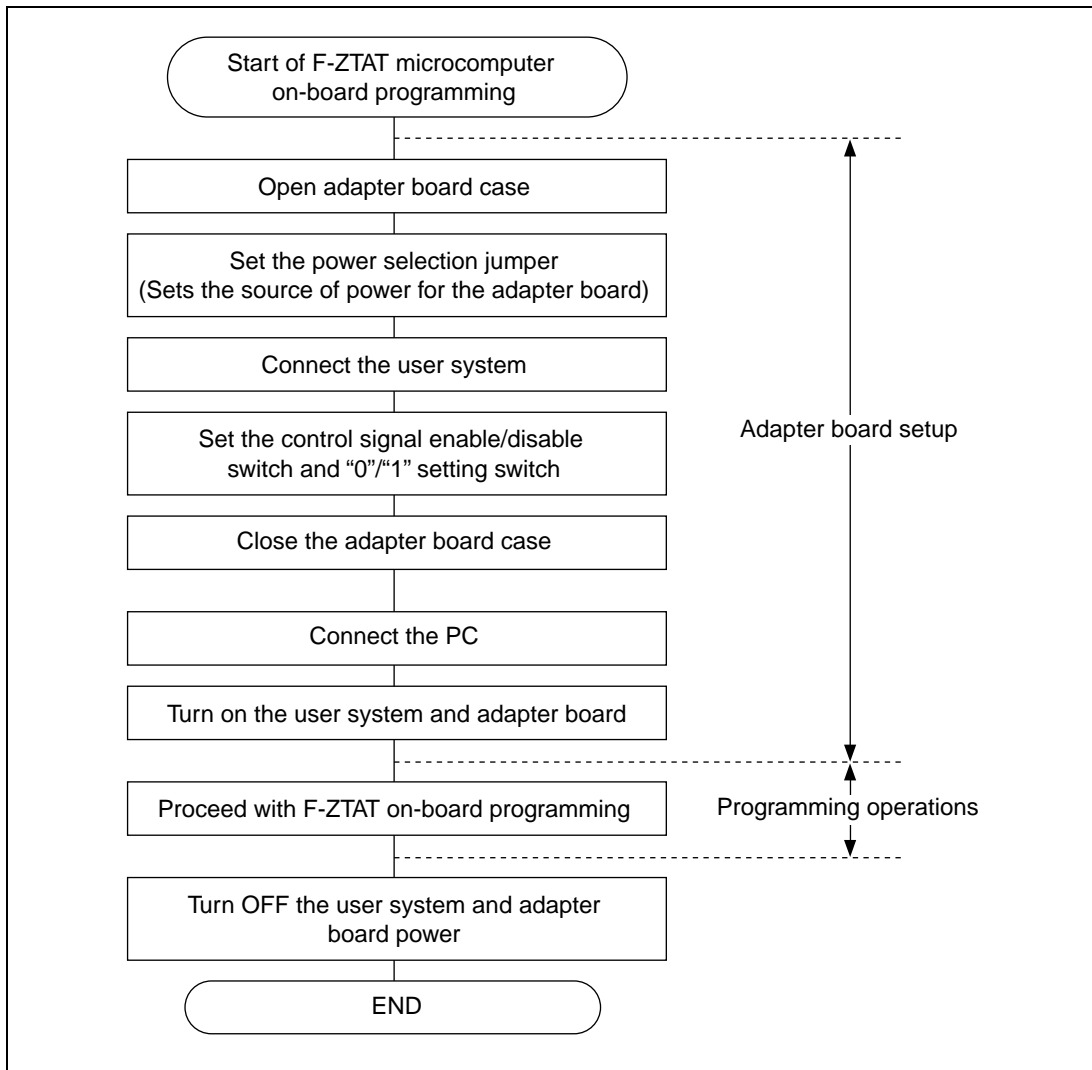


Figure 2.4 Example Sequence of Adapter Board Operation

2.1.4 Opening and Closing Adapter Board Case

Figure 2.5 shows how to open and close the adapter board case. When setting the power selection jumper (JP1), control signal enable/disable switch (S4), and “1”/“0” setting switch (S3), open the case as shown in Figure 2.5. Close the case again after making the necessary settings.

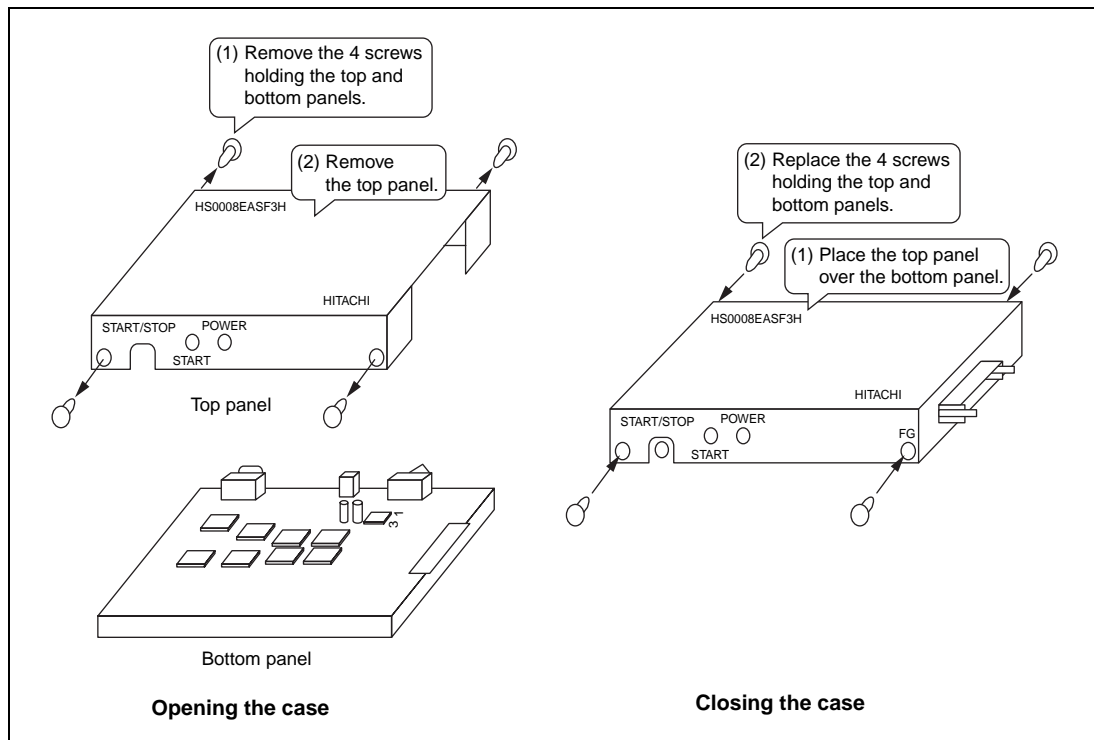


Figure 2.5 Opening and Closing Adapter Board Case

2.1.5 Setting the Power Selection Jumper

The power selection jumper selects the power source for the adapter board. There are two sources, as follows:

Figure 2.6 and Figure 2.7 shows the power source and the power selection jumper.

(1) Supply from User System via User Interface Connector (VIN Pin)

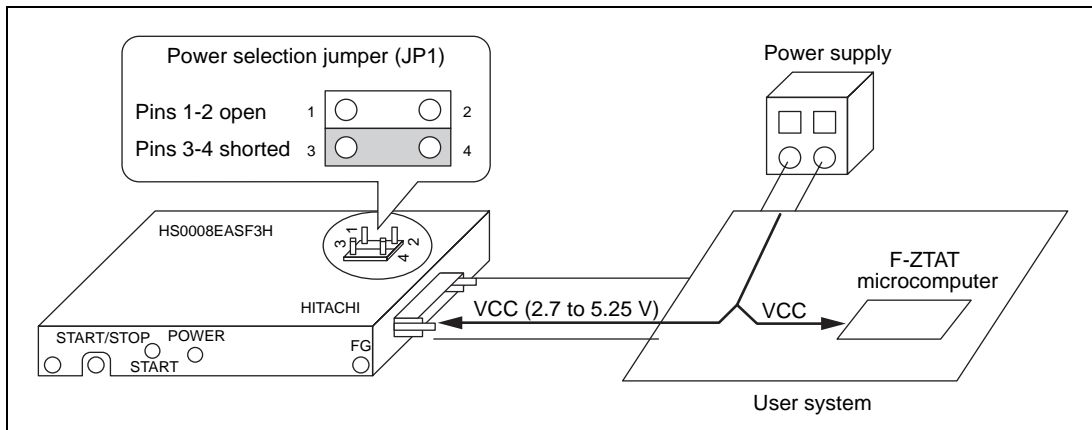


Figure 2.6 Supplying Power from User System

Note: The adapter board has a consumption of 200 mA (Typ)/5 V. Make sure, when supplying power from the user system, that there is sufficient capacity.

(2) Supply from External Power Supply via Power Supply Connector (P3)

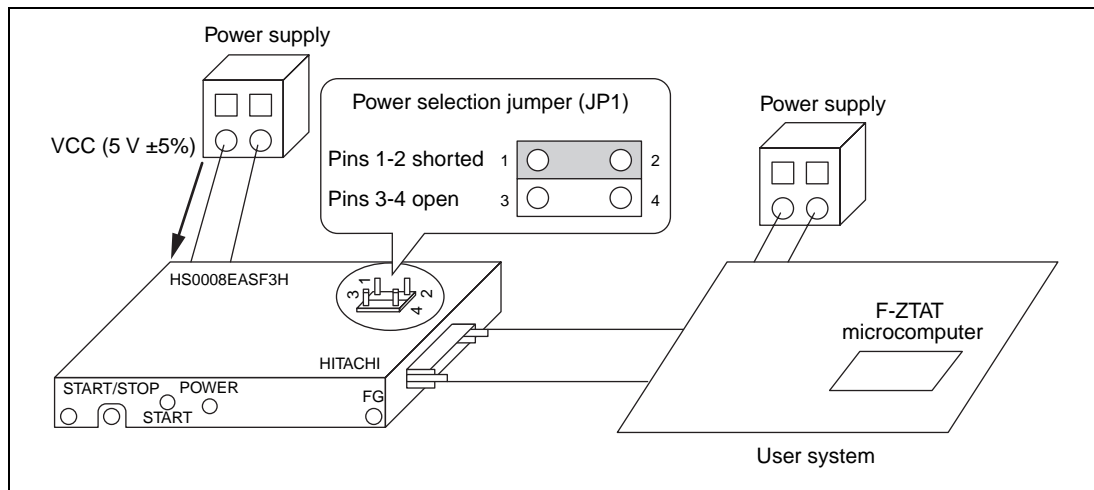


Figure 2.7 Supplying Power from External Power Supply

Note: Be sure to connect the user system power supply to the adapter board via the user interface connector pin VIN even when supplying power to the adapter board from an external power supply.

It is possible for writing or erasing to occur if the write control signal is input to the F-ZTAT microcomputer when Vcc is too low. To prevent this, the adapter board has a function that continuously monitors the power supply of the user system at the VIN pin and cuts the write control signal from being sent to the F-ZTAT microcomputer if the voltage drops below 2.6 V (Typ).

2.1.6 Connecting Adapter Board and User System

(1) UserInterface Connector (P1) and User System Connection Cable

Figures 2.8 and 2.9 show the pin configuration of the user interface connector on the adapter board, and the user system connection cable specifications.

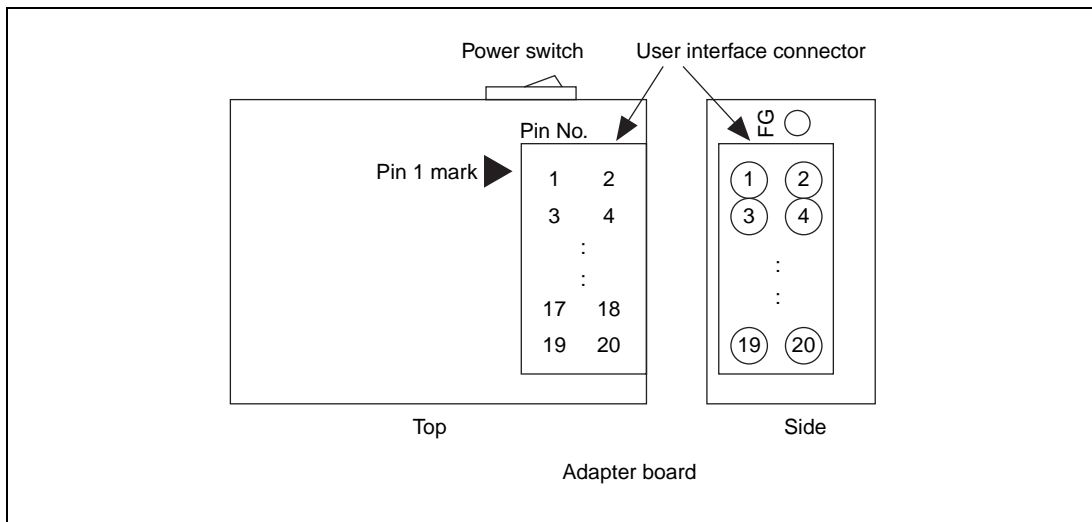


Figure 2.8 Pin Configuration of User Interface Connector

Pin No.	Name	Remarks
1	RES ^{*1}	Outputs a reset signal to the F-ZTAT microcomputer on the user system.
2, 4, 6, 8, 10, 12, 14, 16	GND ^{*1}	Ground
3	FFW/FWP ^{*2}	Outputs the write enable signal (High or Low level) to the F-ZTAT microcomputer on the user system.
5	MD0 ^{*2}	Outputs the write control signal (High or Low level) to the MD pin on the F-ZTAT microcomputer on the user system.
7	MD1 ^{*2}	Outputs the write control signal (High or Low level) to the MD pin on the F-ZTAT microcomputer on the user system.
9	I/O 0 ^{*2}	Outputs the write control signal (High or Low level) to the I/O pin on the F-ZTAT microcomputer on the user system.
11	I/O 1 ^{*2}	Outputs the write control signal (High or Low level) to the I/O pin on the F-ZTAT microcomputer on the user system.
13	I/O 2 ^{*2}	Outputs the write control signal (High or Low level) to the I/O pin on the F-ZTAT microcomputer on the user system.
15	RXD (User side: TXD) ^{*1}	Receives serial data from the user system.
17	TXD (User side: RXD) ^{*1}	Sends serial data to the user system.
18	VIN (V _{cc}) ^{*1}	Inputs Vcc (2.7 to 5.25 V) from the user system.
19	NC	N.C.
20	VIN (V _{cc}) ^{*1}	Inputs Vcc (2.7 to 5.25 V) from the user system.

Notes: 1. Always connect to user system.

2. Connect as appropriate for the respective F-ZTAT microcomputer write control signal pins. Note that signals output from this pin can be enabled or disabled and the level, when enabled, set high or low.

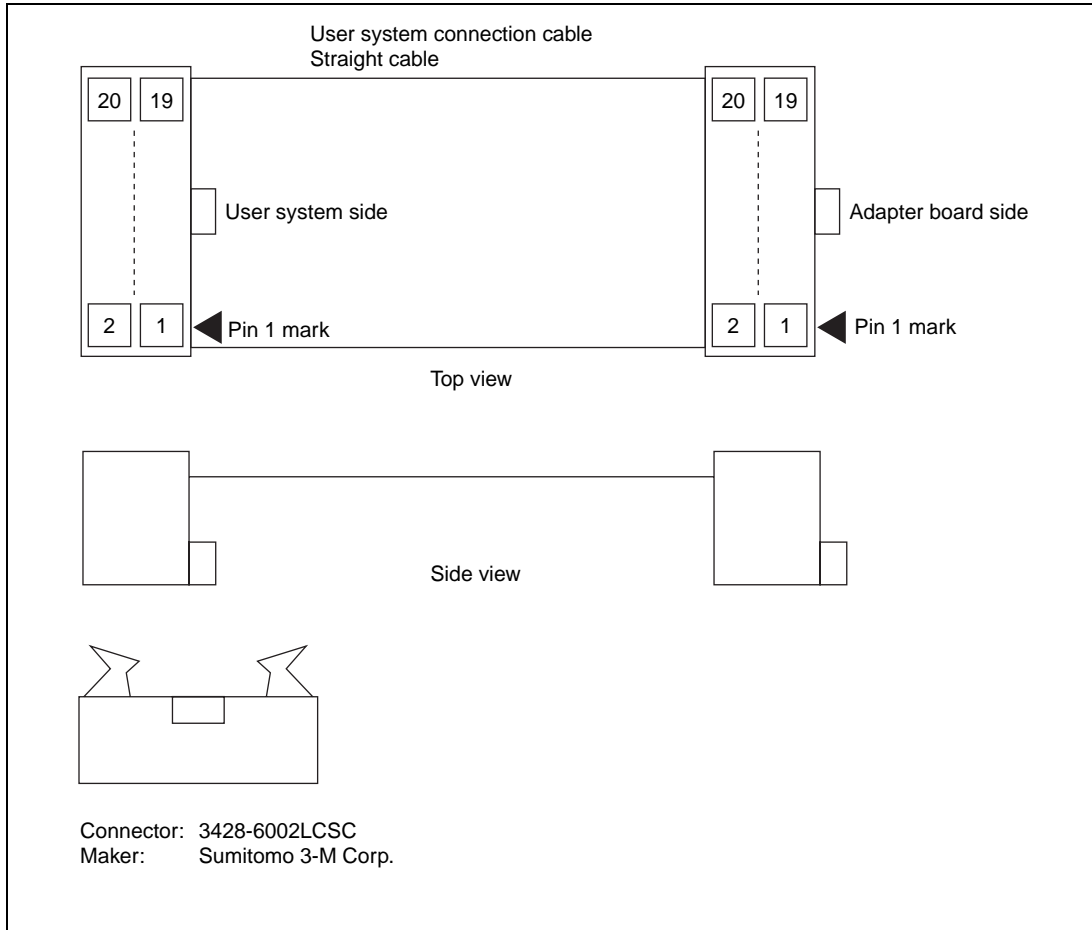


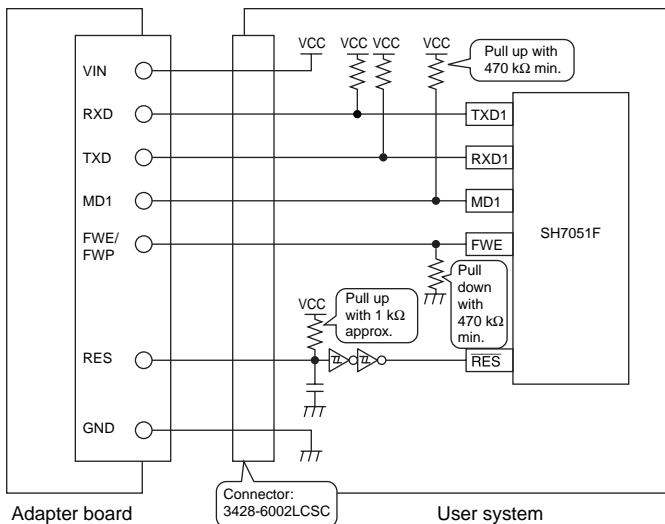
Figure 2.9 User System Connection Cable Specifications

(2) Connecting the User System

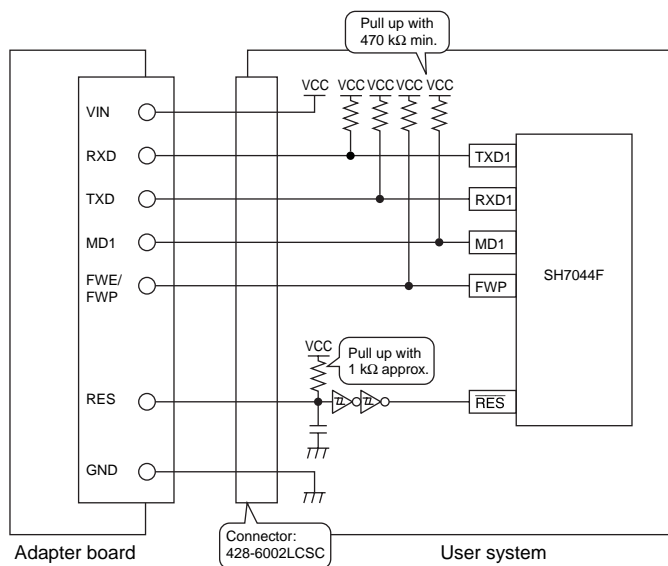
Before connecting the adapter board to the user system, prepare the user system as follows:

1. Install a connector for connecting the user system connection cable to the user system. Use the *Sumitomo 3-M Corp 3428-6002LCSC connector*.
2. The RES pin on the adapter board is an open collector output. Pull up the RES pin of the adapter board with a 1 kilohm (approx.) resistor on the user system.
3. On the user system, pull up or pull down the following write control signals with a 470 kilohm, or greater, resistor: FWE/WFP, MD0, MD1, IO0, IO1, and IO2. Do not connect the write control signal directly to Vcc or GND.

Figure 2.10 shows example connections for the respective F-ZTAT microcomputer models.

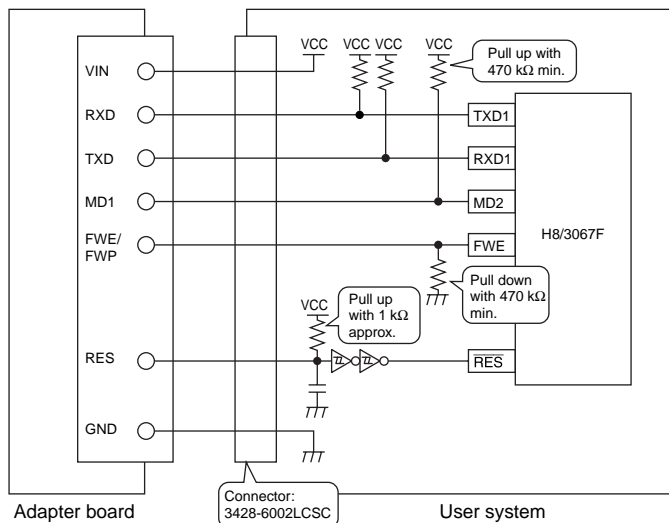


Example Adapter Board Connection to SH7051F

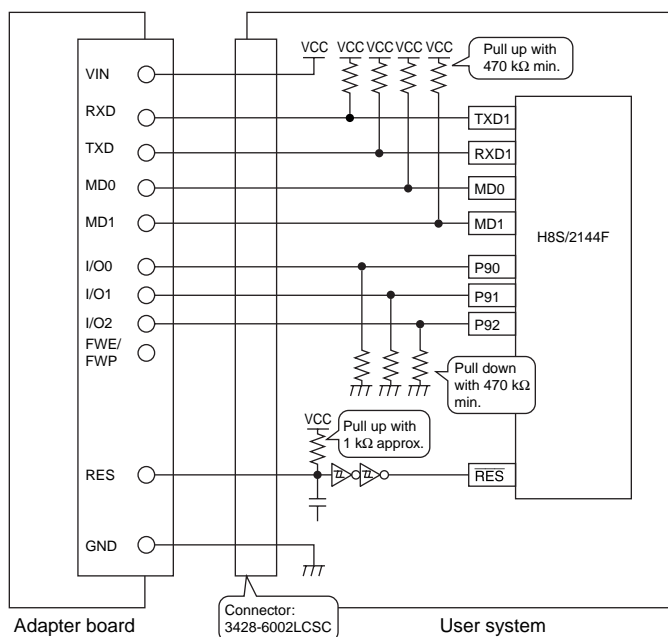


Example Adapter Board Connection to SH7044F

Figure 2.10 Example Adapter Board and F-ZTAT Microcomputer Connections (1)



Example Adapter Board Connection to H8/3067F



Example Adapter Board Connection to H8S/2144F

Figure 2.10 Example Adapter Board and F-ZTAT Microcomputer Connections (2)

Note: The example H8S/2144F connection shown in Figure 2.10 is when using operating mode 3 for normal execution (running the application program in flash memory). When using operating mode 2 for normal execution, pull down the MD0 pin.

2.1.7 Control Signal Enable/Disable Switch, and “1”/“0” Setting Switch

As shown in Table 2.3, the control signal enable/disable switch (S4) controls the write control signal.

The “1”/“0” setting switch (S3) sets the write control signal level, when enabled by the enable/disable switch, to “0” (Low) or “1” (High).

Table 2.3 shows how to set the control signal enable/disable switch and “1”/“0” setting switch.

Table 2.4 shows example settings for each of the F-ZTAT microcomputers. The example settings in Table 2.4 are for the example adapter board and F-ZTAT microcomputer connections shown in Figure 2.10.

Table 2.3 Control Signal Enable/Disable Switch and “1”/“0” Setting Switch



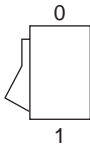
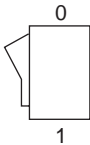
Switch No.	Control Signal	Enable/Disable Switch		0/1 Setting Switch	
		E Setting	D Setting	Set to “0”	Set to “1”
1	FWE/FWP	Enabled	Disabled	Low	High
2	MD0	Enabled	Disabled	Low	High
3	MD1	Enabled	Disabled	Low	High
4	I/O 0	Enabled	Disabled	Low	High
5	I/O 1	Enabled	Disabled	Low	High
6	I/O 2	Enabled	Disabled	Low	High
Switch position (side view)					

Table 2.4 Sample Settings for F-ZTAT Microcomputers

Adapter Board Write Control Signal	SH7051F					SH7044F				
	Con-nected Pin	Boot Mode		User Program Mode		Con-nected Pin	Boot Mode		User Program Mode	
		S4	S3	S4	S3		S4	S3	S4	S3
FEW/FWP	FWE	E	1	E	1	FWP	E	0	E	0
MD0	—	D	*	D	*	—	D	*	D	*
MD1	MD1	E	0	D	*	MD1	E	0	D	*
I/O0	—	D	*	D	*	—	D	*	D	*
I/O1	—	D	*	D	*	—	D	*	D	*
I/O2	—	D	*	D	*	—	D	*	D	*

Adapter Board Write Control Signal	H8/3067F					H8S/2144F				
	Con-nected Pin	Boot Mode		User Program Mode		Con-nected Pin	Boot Mode		User Program Mode	
		S4	S3	S4	S3		S4	S3	S4	S3
FEW/FWP	FWE	E	1	E	1	—	D	*	D	*
MD0	—	D	*	D	*	MD0	E	0	D	*
MD1	MD2	E	0	D	*	MD1	E	0	D	*
I/O0	—	D	*	D	*	P90	E	1	D	*
I/O1	—	D	*	D	*	P92	E	1	D	*
I/O2	—	D	*	D	*	P93	E	1	D	*

S4: Write control signal enable/disable switch

D: Set to “D” (Disable).

E: Set to “E” (Enable).

S3: “0”/“1” setting switch

0: Set to “0”.

1: Set to “1”.

*: Set to either “0” or “1”.

2.1.8 Connecting PC and Adapter Board

Use the supplied serial interface cable to connect the adapter board to a PC. The supplied serial interface cable is designed for connection to an IBM PC*.

Figure 2.11 shows how to connect the adapter board to a PC.

Note: * IBM PC is a registered trademark of International Business Machines Corporation.

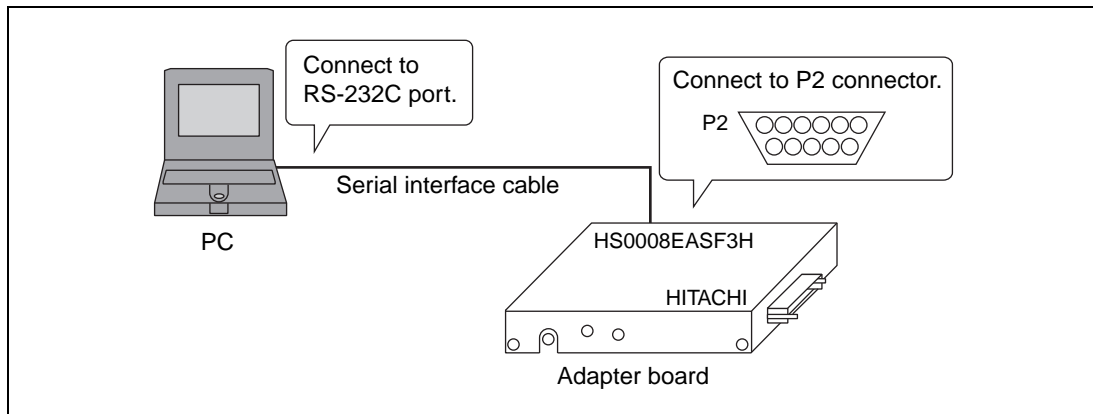


Figure 2.11 Connecting Adapter Board and PC

2.1.9 Turning the Adapter Board ON/OFF

Use the POWER switch to turn the adapter board ON and OFF.

Figure 2.12 shows how to set the POWER switch. Note that the POWER switch works only when the adapter board power is supplied via the power connector (P3). When power is supplied to the adapter board from the user system, the power switch on the user system also functions as the power switch for the adapter board.

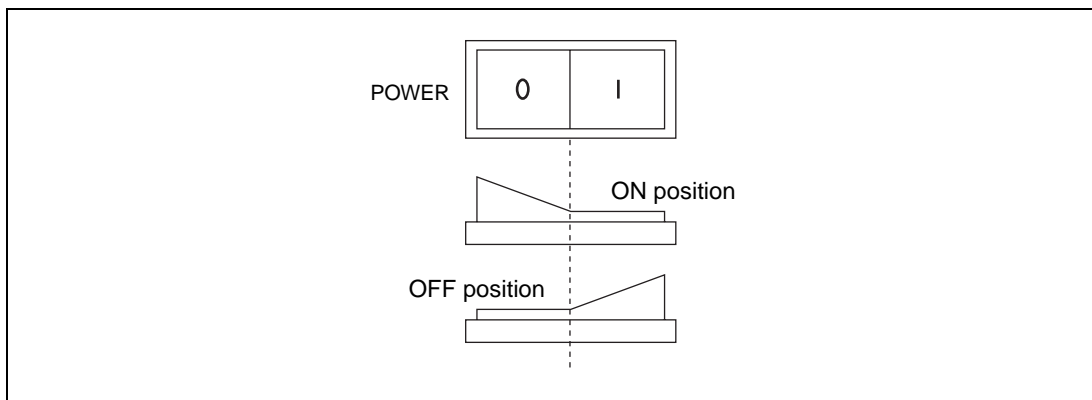


Figure 2.12 POWER Switch Positions

2.2 On-board Programming Software

2.2.1 Overview of On-board Programming Software

(1) Overview

The on-board programming software allows application programs on an IBM-PC^{*1} or NEC PC-9801^{*2} to be written to the flash memory in an F-ZTAT microcomputer installed in the user system.

Notes: 1. IBM-PC is a registered trademark of International Business Machines Corporation.
2. PC-9801 is a trademark of NEC.

(2) Functions

- Boot mode
 - Sets the transfer rate between the host machine and the F-ZTAT microcomputer (automatic bit rate matching);
 - Transfers write control program to internal RAM of F-ZTAT microcomputer;
 - Writes the application program (in S-type format) on the host machine to the flash memory;
 - The write control program transferred to the internal RAM controls the writing to flash memory and the receiving of the application program.
- User program mode
 - Writes the application program (in S-type format) on the host machine to the flash memory;
 - From the host machine, individual block areas in flash memory can be selected for erasing.
 - The write/erase control program supplied with the on-board programming software can be preloaded in flash memory, then, when user program mode is started, transferred to internal RAM and run. In this way, it can control the writing to and erasing of flash memory, and the reception of the application programs.

(3) Connections

The method of connecting the user system to the host machine is shown in figure 2.13.

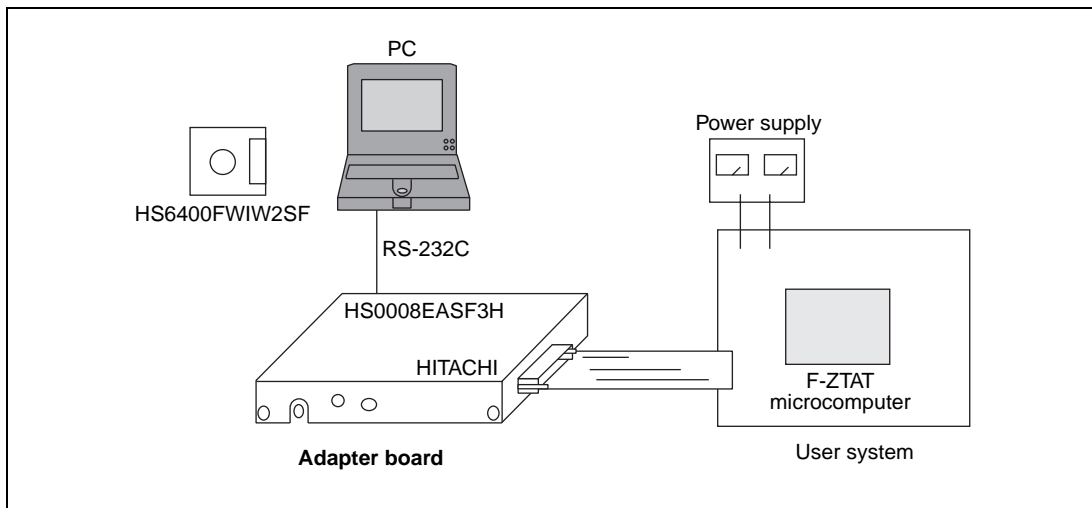


Figure 2.13 Connection of User System and Host Machine

(4) Operating Environment and Product Nos.

Table 2.5 lists the operating environment for the on-board programming software. (Note that the transfer rate in boot mode depends on the operating frequency.)

Table 2.5 Operating Environment

Transfer rate	9600, 4800, 2400 bps
Sync system	Async
Data bits	8
Stop bit	1
Parity	None

Table 2.6 lists the product No. and MS-DOS version of the on-board programming software.
Table 2.7 lists the files supplied with the software.

Table 2.6 On-board Programming Software Products

Host Machine	Product No.	Development Environment
PC-9801	HS6400FWPW1SF	Windows 3.1 or Windows 95
IBM-PC	HS6400FWIW1SF	

Table 2.7 Structure of On-board Programming Software Files

F-ZTAT Microcomputer								
File	H8/3067F,			H8S/2144F,		SH7050F/ SH7044F/		
	H8/539F	62F	H8/3039F	34F, 48F, 38F, 28F	H8S/2142F, 32F	H8S/2357F	51F	45F
Flash memory programming software	FLASH. EXE (common)	FLASH. EXE (common)	FLASH. EXE (common)	FLASH. EXE (common)	FLASH. EXE (common)	FLASH. EXE (common)	FLASH. EXE (common)	FLASH. EXE (common)
Flash memory block information file	539.inf	3067s.inf	3039s.inf	2144.inf	2144.inf	2357.inf	7050.inf/ 7051.inf	7044.inf/ 7045.inf
User write/erase control program	539.sub	3067.sub	3039s.sub	2144.sub	2144.sub	2357.sub	7050.sub/ 7051.sub	7044.sub/ 7045.sub
User write/erase control program source file	539.src	3067.src	3039s.src	2144.src	2144.src	2357.src	7050.src/ 7051.src	7044.src/ 7045.src

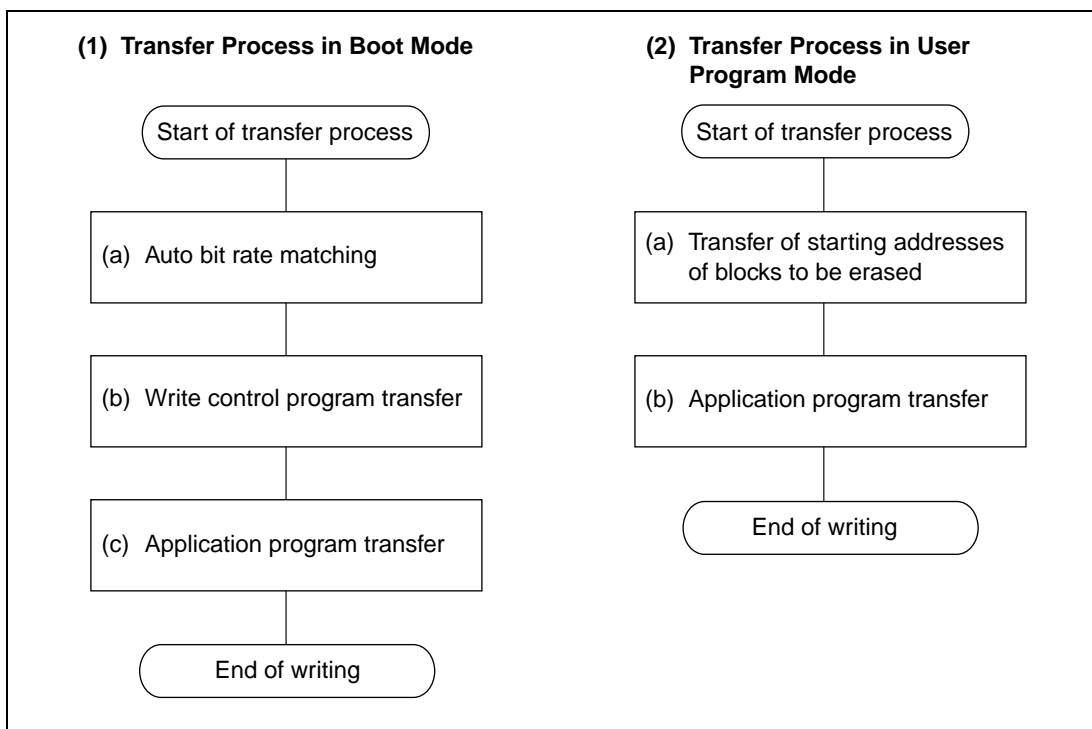
2.2.2 On-board Programming Software Transfer Process

Table 2.8 shows the on-board programming software transfer process.

When running boot mode or user program mode, the on-board programming software writes to or erases from the F-ZTAT microcomputer according to the transfer processes shown in Table 2.8. Figure 2.14 shows the transfer processes in each mode as flowcharts. Figure 2.14 (1) and (2) shows details.

Table 2.8 On-board Programming Software Transfer Process

Name of Transfer process	Control
• Auto bit-rate matching	• In boot mode, sets the transfer rate between the host machine and F-ZTAT microcomputer (continuous transmission of H'00)
• Write control program transfer	• Transfers the write control program to the internal RAM of the F-ZTAT microcomputer (binary data)
• Erase target block starting address transfer	• Transfers the starting addresses of the blocks to be erased so that block areas in flash memory can be erased (binary data)
• Application program transfer	• Transfers the application program to be written to flash memory (binary data).

**Figure 2.14 On-Board Programming Software Transfers in Boot Mode and User Program Mode**

(1) Transfer Process in Boot Mode

Steps 1 to 3 below detail the on-board programming software transfer process in boot mode.

1. Auto bit rate matching

Auto bit rate matching is performed only when boot mode is selected on the host machine.

Figure 2.15 shows the auto bit rate matching process.

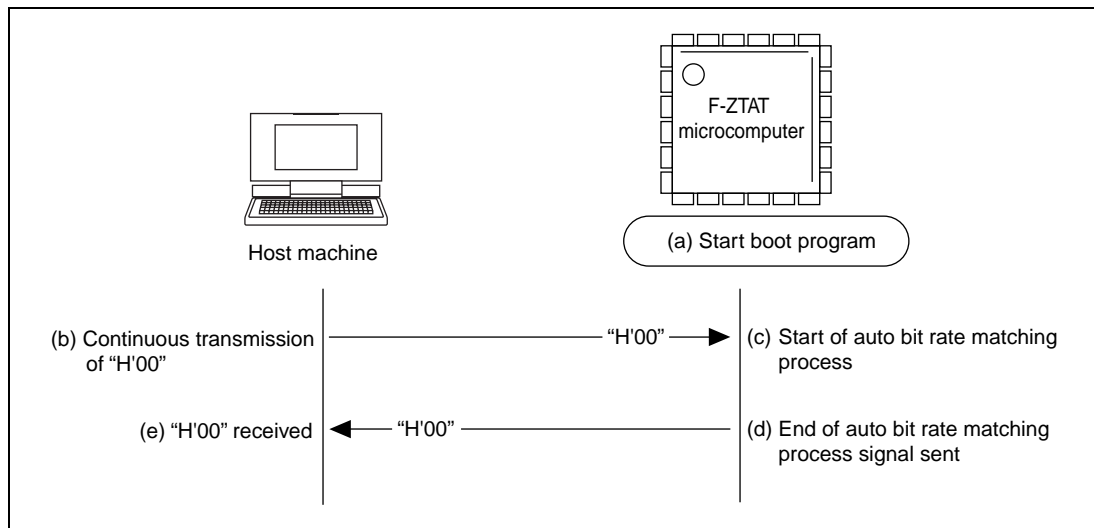


Figure 2.15 Auto Bit Rate Matching Process

Description:

- (a) A voltage is applied to the FWE (or FWP) pin and the mode pin (boot mode setting pin) of the F-ZTAT microcomputer to start boot mode, and the boot program starts.
- (b) The host machine continuously sends code "H'00".
- (c) The boot program measures the low duration of the received "H'00" and starts the auto bit rate matching process (to set the transfer rate).
- (d) After auto bit rate matching is complete (the transfer rate is set), the boot program sends end code "H'00".
- (e) The host machine receives the auto bit rate end code "H'00".

Note: The auto bit rate matching process (transfer rate setting) is dependent on the operating frequency of the F-ZTAT microcomputer. The host machine continuously sends "H'00" at 9600bps to the F-ZTAT microcomputer. When it receives end code "H'00", it quits the auto matching process. If it does not receive code "H'00", it drops the transfer rate first to 4800bps, then 2400bps, and continues to send "H'00" until it receives "H'00". If, even at 2400bps, it does not receive "H'00", it displays a "Time-out error" message. See the section on "Auto Bit Rate Matching" in the respective F-ZTAT microcomputer manuals for details.

2. Write control program transfer

The write control program transfer is performed after auto bit rate matching. Figure 2.16 shows the steps in the write control program transfer.

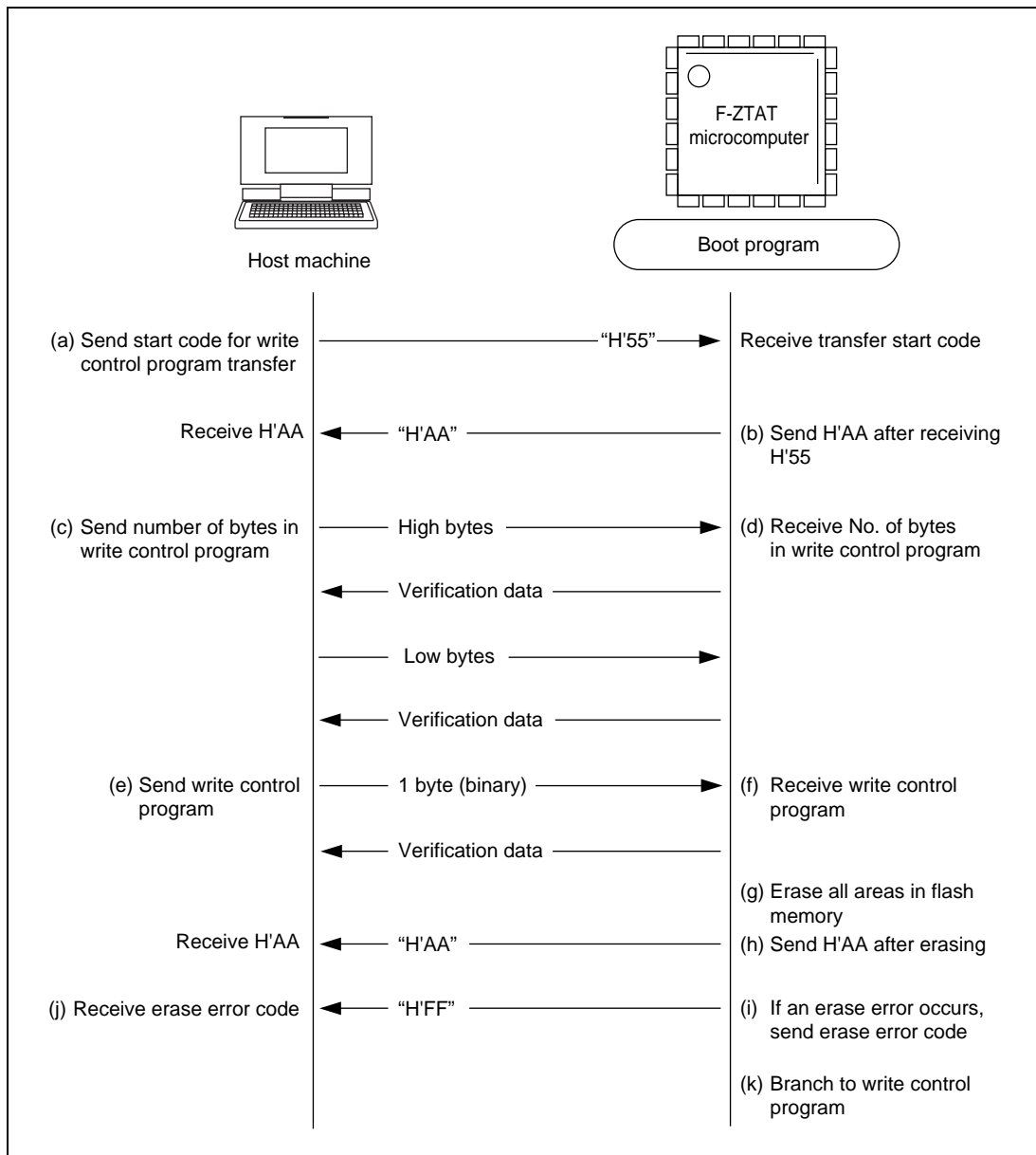


Figure 2.16 Write Control Program Transfer

Description:

- (a) After receiving the end signal for auto bit rate matching, the host machine sends “H'55” to signal the start of write control program transfer.
- (b) On receipt of the “H'55” signal, the boot program sends “H'AA”.
- (c) The host machine then sends the number of bytes in the write control program as the high digit byte followed by the low digit byte.
- (d) The boot program sends back verify data for the received number of bytes (specified by the host machine) for each digit byte (echo back).
- (e) The host machine sends the write control program as binary data in 1-byte units.
- (f) The boot program transfers the received write control program to internal RAM, and sends back the verify data for each byte received (echo back).
- (g) When the write control program has been received, the whole flash memory area is erased.
- (h) After the whole flash memory area has been erased, the boot program sends “H'AA”.
- (i) If the boot program cannot clear flash memory, it sends “H'FF” as an erase error signal.
- (j) When it receives the erase error signal (H'FF), the host machine displays error message “Erase error”.
- (k) The boot program branches to the write control program that has been transferred to internal RAM.

Note: The on-board programming software is transferred after the *.SUB file (S-type format) has been converted to binary data.

3. Application program transfer

The application program is transferred after the boot program has erased the flash memory.

Figure 2.17 shows the steps in transferring the application program in boot mode.

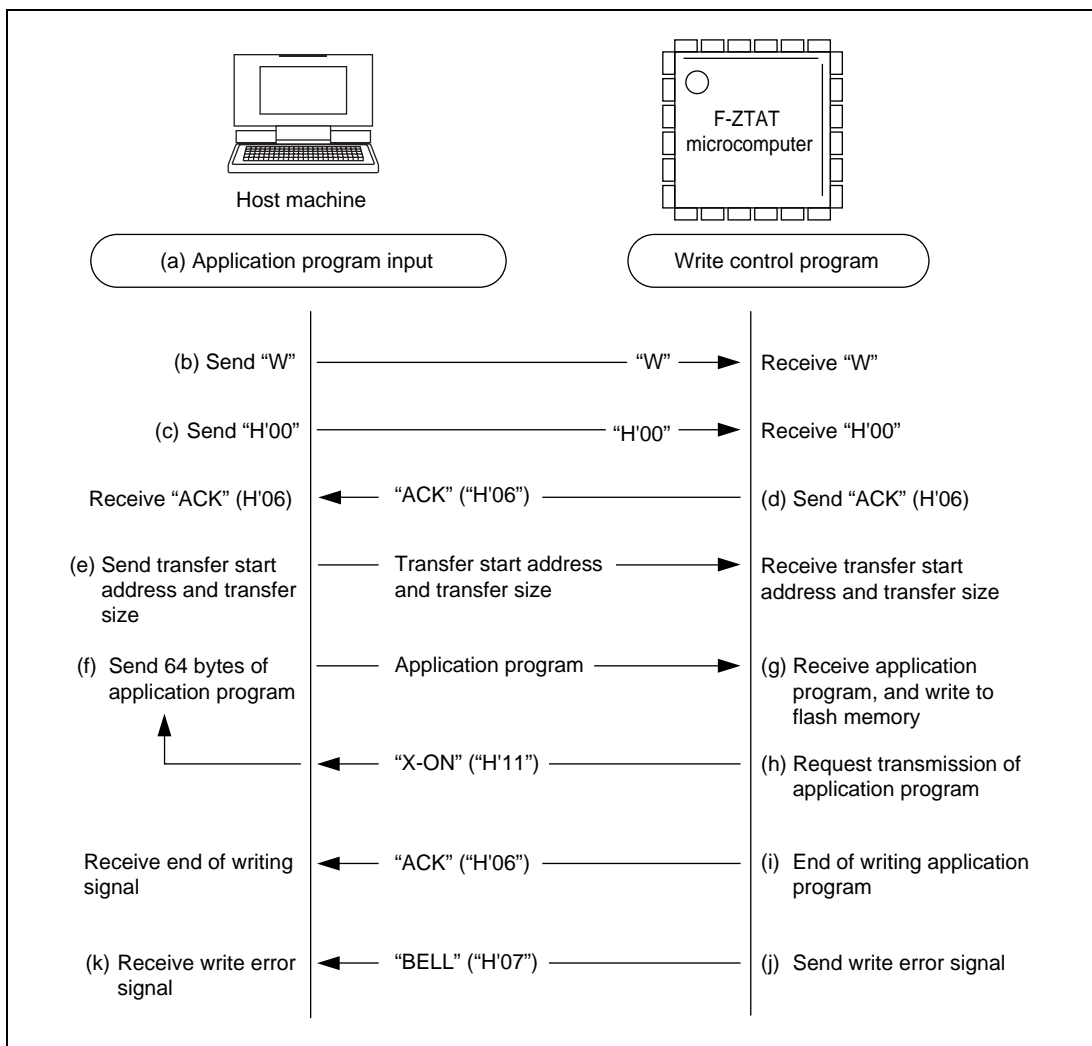


Figure 2.17 Application Program Transfer in Boot Mode

Description:

- (a) Input the name of the application program file to be written to flash memory on the host machine.
- (b) The host machine sends the “W” command.
- (c) The write control program sends the transmit enable signal “X-ON” (H'11) and requests that the host machine send the application program.
- (d) 64 bytes of the application program are sent from the host machine.
- (e) The write control program receives the application program and writes it to flash memory.
- (f) If the received record is not the last record (S9 and S8 records) of the application program, the write control program sends “X-ON” to request that the host machine sends the application program.
- (g) On completion of writing, the write control program sends the end-of-writing signal “ACK” (H'06).
- (h) If a write error occurs, the write control program sends the write error signal “BELL” (H'07).
- (i) When the host machine receives the “BELL” write error signal, it displays the “Write error” error message on the host machine.

Note: The on-board programming software converts the application program (*.MOT file: S-type format) into binary before transfer.

(2) File Transfer in User Program Mode

The following describes the steps involved in transferring the on-board programming software in user program mode.

- Sending starting address of erasion block and sending application program

The starting address of the erasion block is sent after inputting the application program to be written to flash memory on the host machine and selecting the target block of flash memory to be erased. The application program is sent after erasing flash memory. Figure 2.18 shows the steps in sending the starting address of the erasion block and the steps in sending the application program in user program mode.

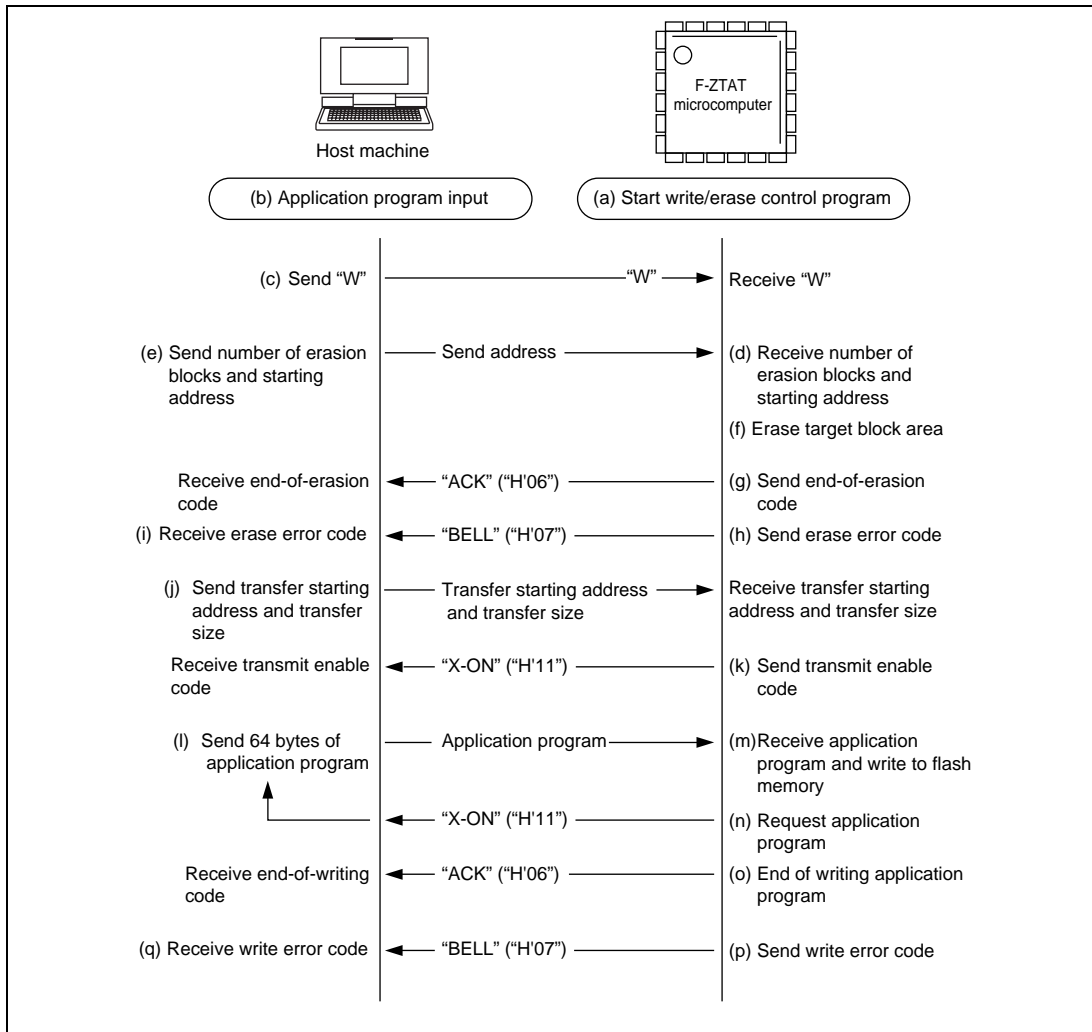


Figure 2.18 Sending Erasion Block Starting Address and Application Program

Description:

- (a) In user program mode, the write/erase control program already written to flash memory is transferred to and run from internal RAM.
- (b) On the host machine, select user program mode, set the transfer rate, input the filename of the application program to be written to flash memory, and select the target block area to be erased in flash memory.
- (c) The host machine sends the “W” command.
- (d) The write/erase control program receives “W” and sends the data transmit enable code “X-ON” (H'11).
- (e) The host machine sends the number of blocks to be erased and the starting address.
- (f) The write/erase control program sets the block area starting at the received starting address for erasion.
- (g) The write/erase control program receives the starting address for the erasion block and erases that block.
- (h) The write/erase control program sends the end-of-erasion code “ACK” (H'06).
- (i) If an erase error occurs, the write/erase control program sends the erase error code “BELL” (H'07).
- (j) When it receives the “BELL” erase error code, the host machine displays the “Erasion error” error message.
- (k) The host machine sends the transfer starting address and transfer size.
- (l) After sending the end-of-erasion code, the write/erase control program sends the transmit enable code “X-ON” (H'11) and requests the host machine to send the application program.
- (m) The host machine sends 64 bytes of the application program (in binary).
- (n) The write/erase control program receives the application program and writes it to flash memory.
- (o) If the receive counter is not “0”, the write/erase control program sends “X-ON” to request the host machine to send the application program.
- (p) On completion of writing, the write/erase control program sends the end-of-writing code “ACK” (H'06).
- (q) If a write error occurs, the write/erase control program sends the write error code “BELL” (H'07).
- (r) If the host machine receives the “BELL” write error code, it displays the “Write error” error message on the host machine.

2.2.3 On-board Programming Software Write/Erase Control Program

The on-board programming software write/erase control program is, in boot mode, transferred to the F-ZTAT microcomputer's internal RAM to control the writing to flash memory. In user program mode, the write/erase control program already written to flash memory is transferred to and run from internal RAM to control the writing to and erasing of flash memory.

Figure 2.19 shows the write/erase control program structure. The flowcharts that follow show the detailed for (1) to (8) in Figure 2.19. The “H8/3067F” is used as an example to show the process of writing to and erasing of flash memory.

For details of writing to and erasing of flash memory, see “Flash Memory Writing/Erasing” in the respective F-ZTAT microcomputer hard manuals.

The various waits shown in the flowcharts are representative only. For details, see the respective device user's manuals.

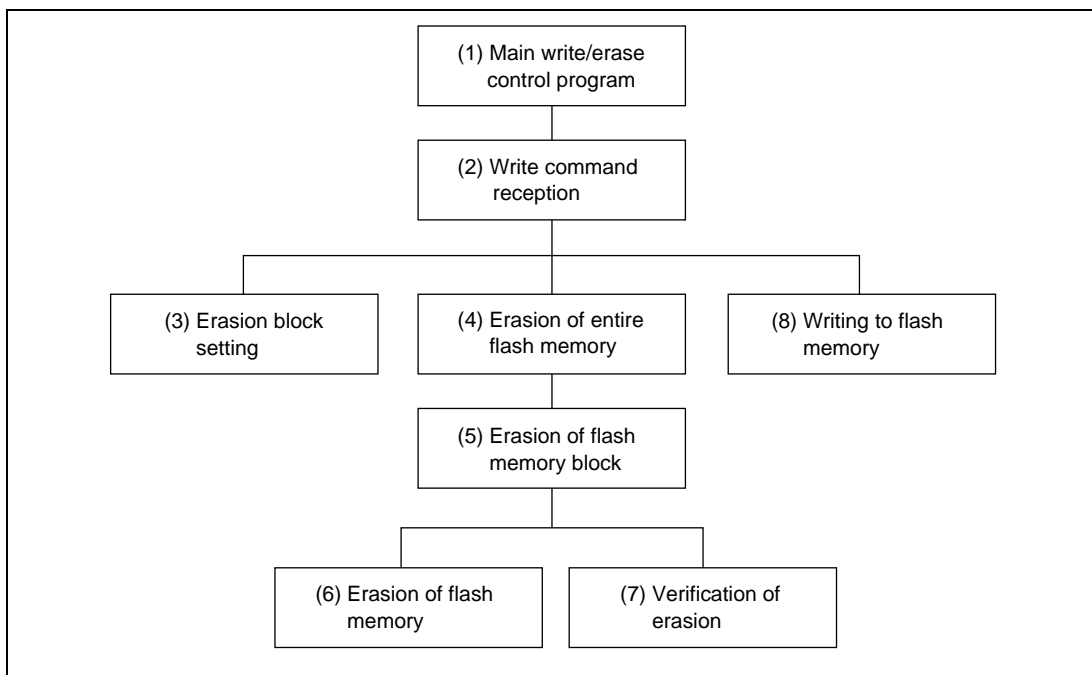
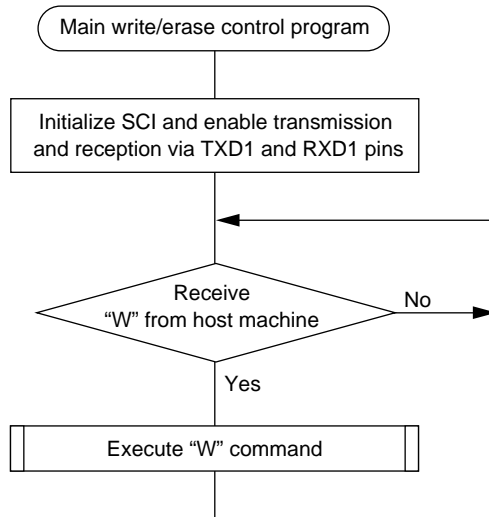
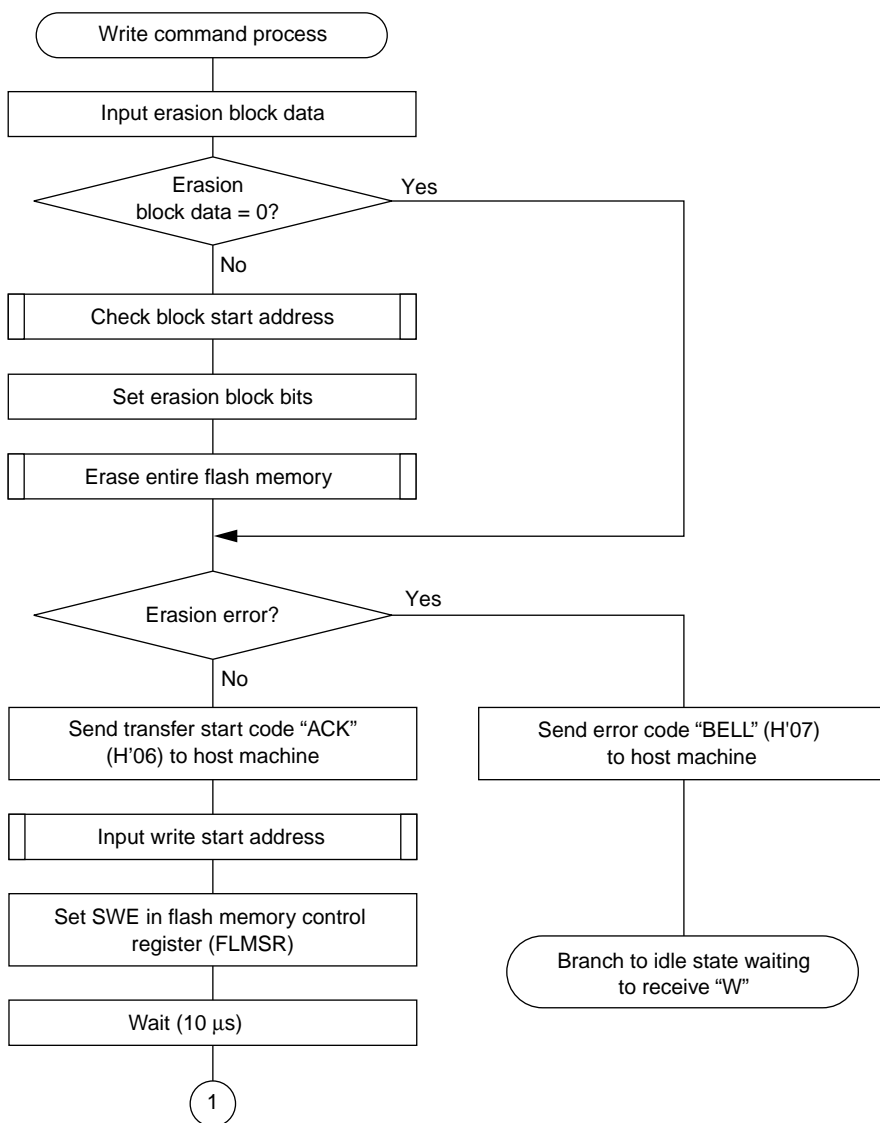


Figure 2.19 Structure of Write/erase Control Program

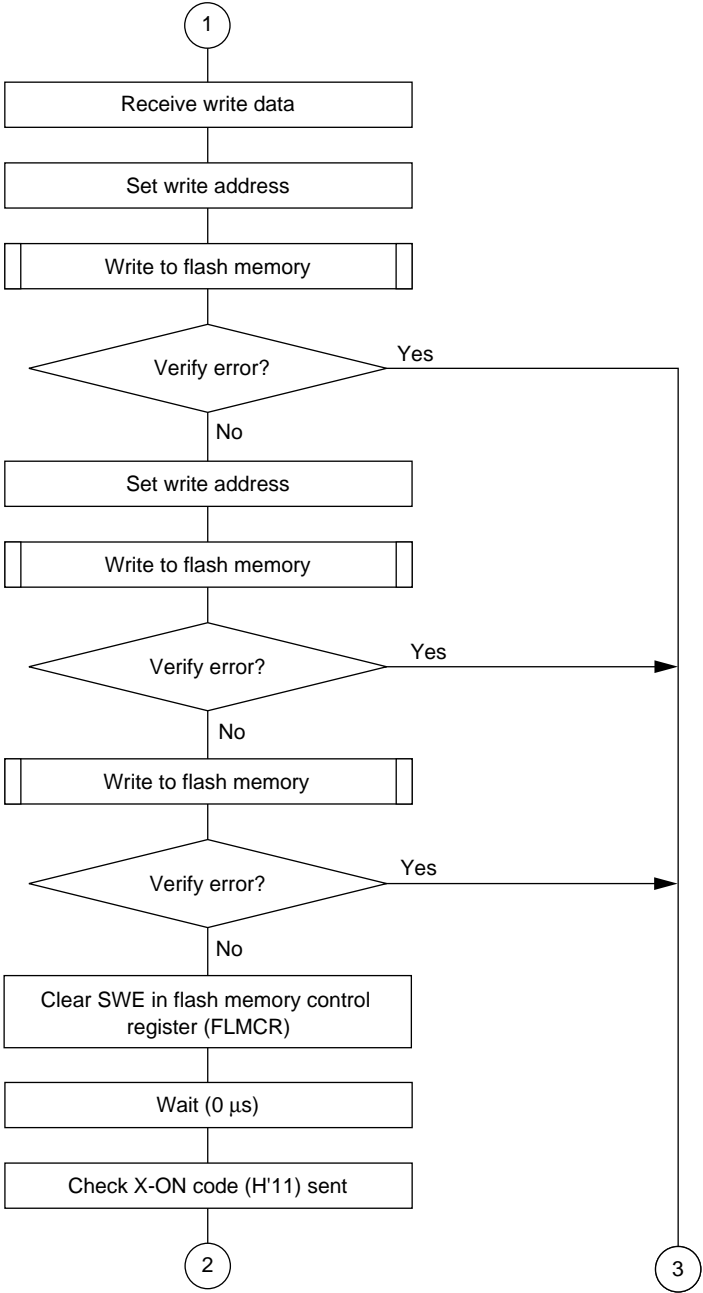
Flowchart Name	(1) Main write/erase control program
Function	Initializes the write control program and receives the "W" command



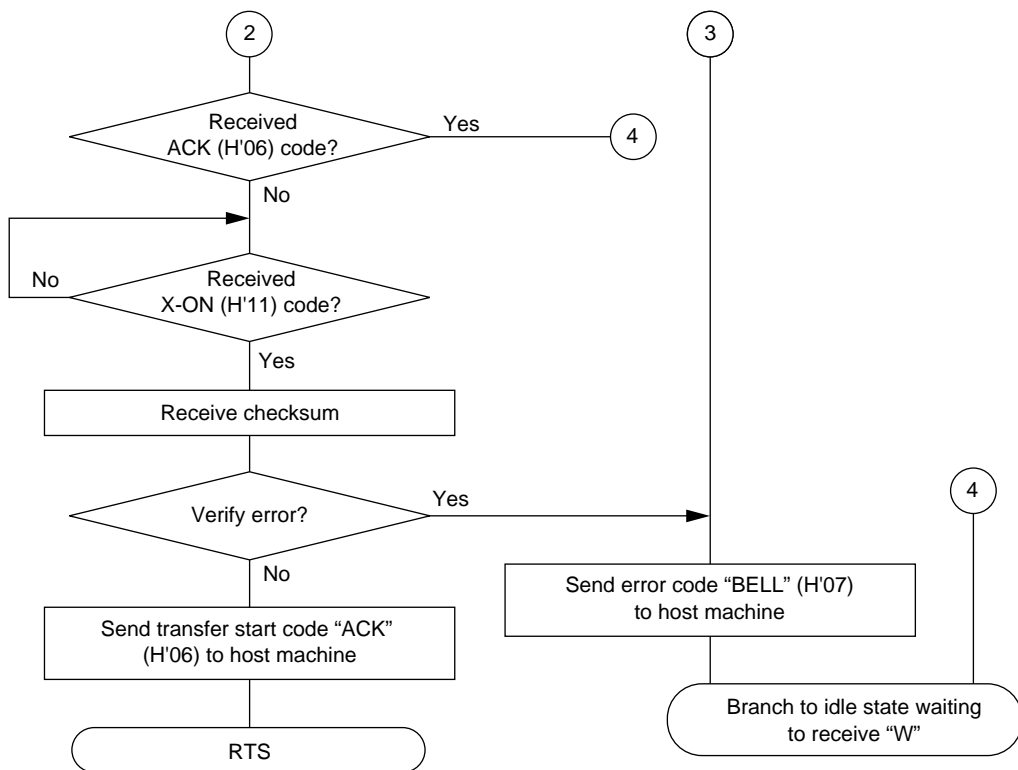
Flowchart Name	(2) Write command process-1
Function	Executes “erase”, “erasure verify”, “write”, and “write verify” as write command processes



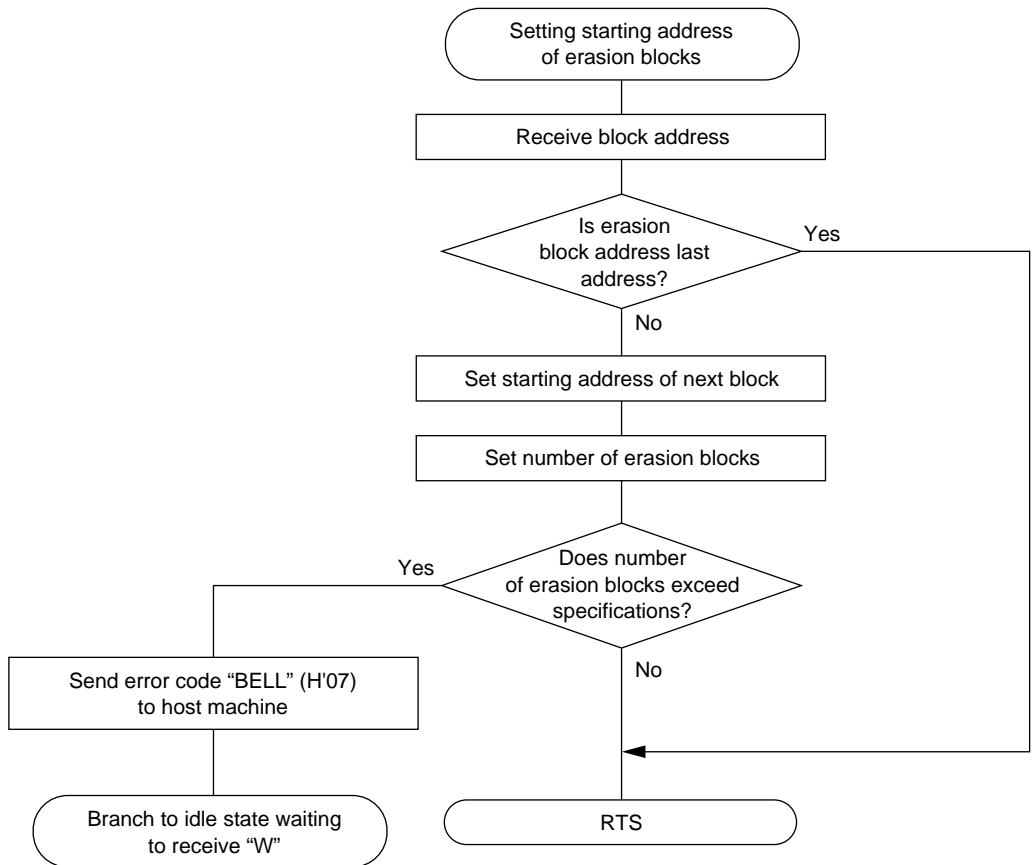
Flowchart Name	(2) Write command process-2
Function	Executes “erase”, “erasure verify”, “write”, and “write verify” as write command processes



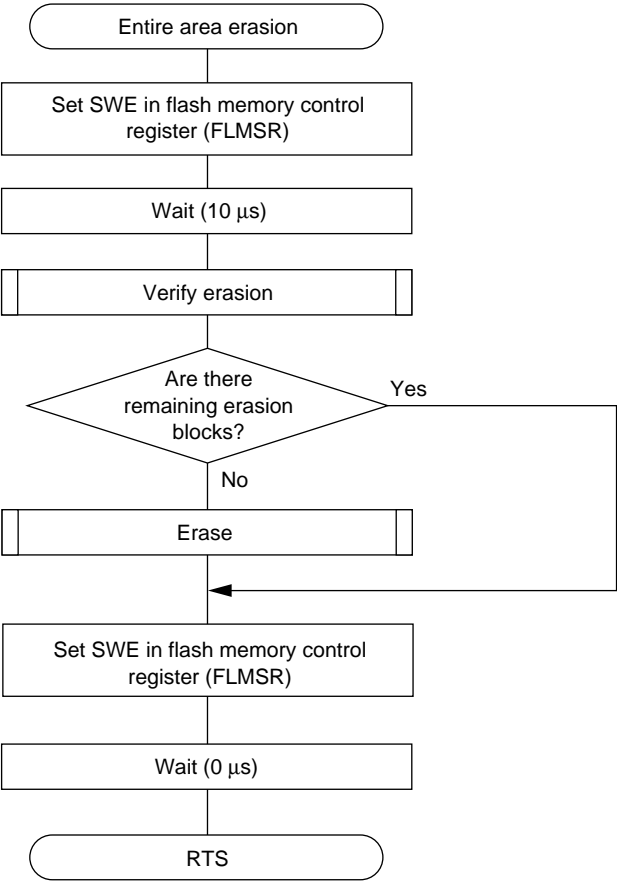
Flowchart Name	(2) Write command process-3
Function	Executes “erase”, “erasion verify”, “write”, and “write verify” as write command processes



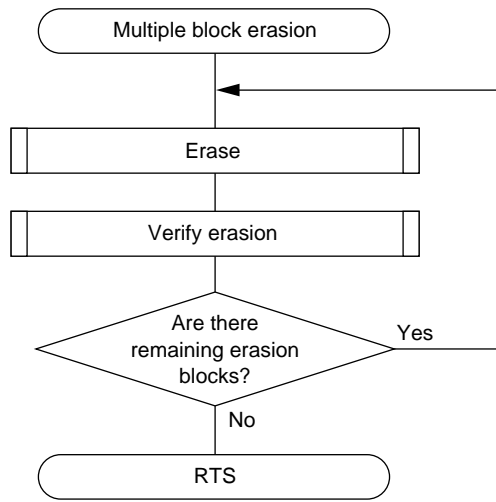
Flowchart Name	(3) Set starting address of erasion block
Function	Receives erasion starting address and calculates number of blocks to be erased



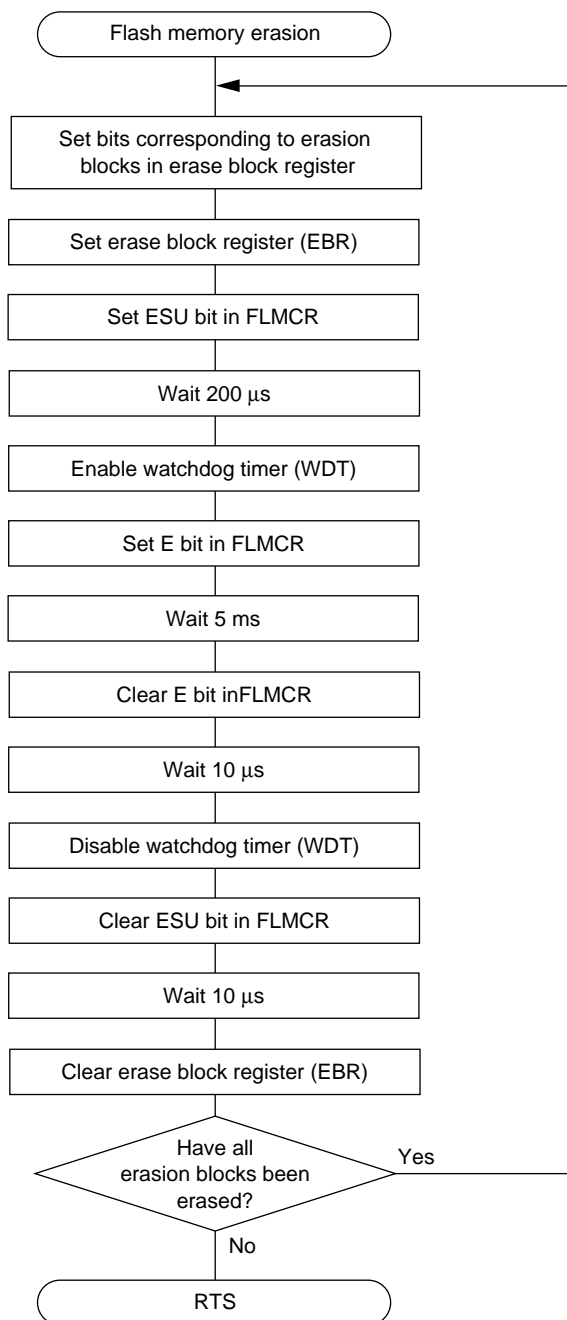
Flowchart Name	(4) Entire area erasion
Function	Verifies the erasion of the target erasion blocks and, if not erased, erases them



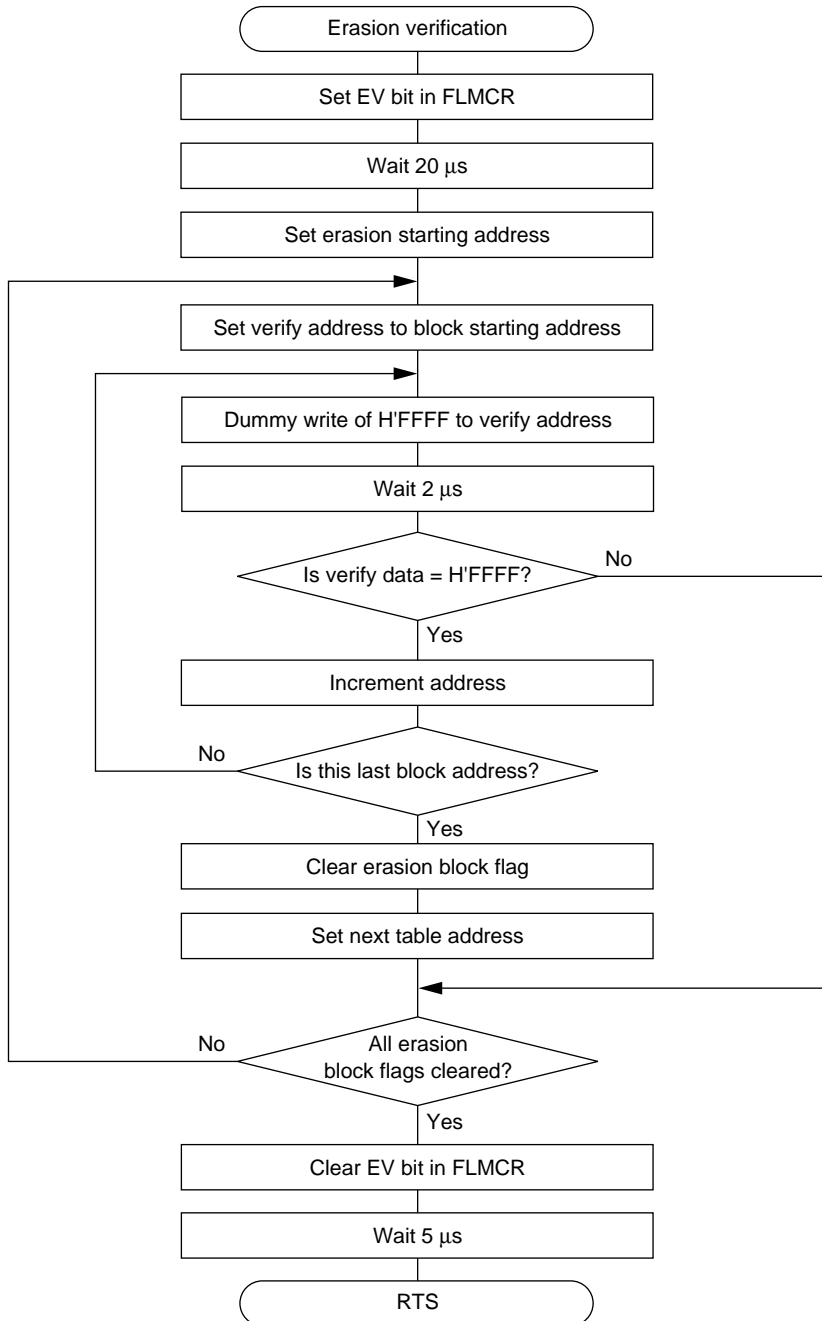
Flowchart Name	(5) Erase multiple blocks
Function	Erases multiple blocks set as erasion blocks



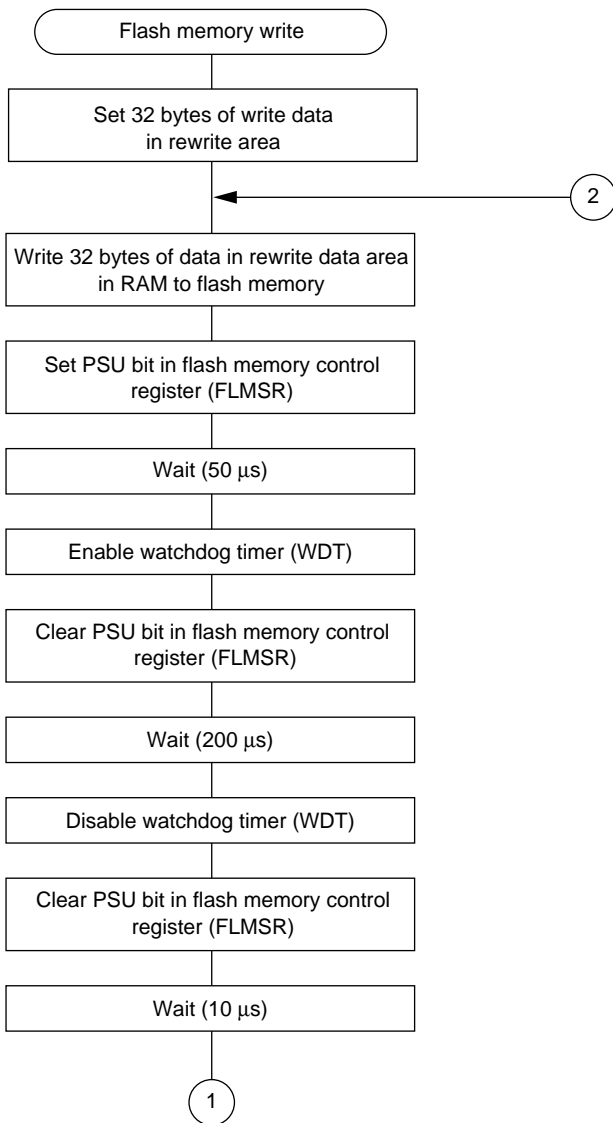
Flowchart Name	(6) Erase flash memory
Function	Sets bits in erase block register according to erasion block data and erases blocks



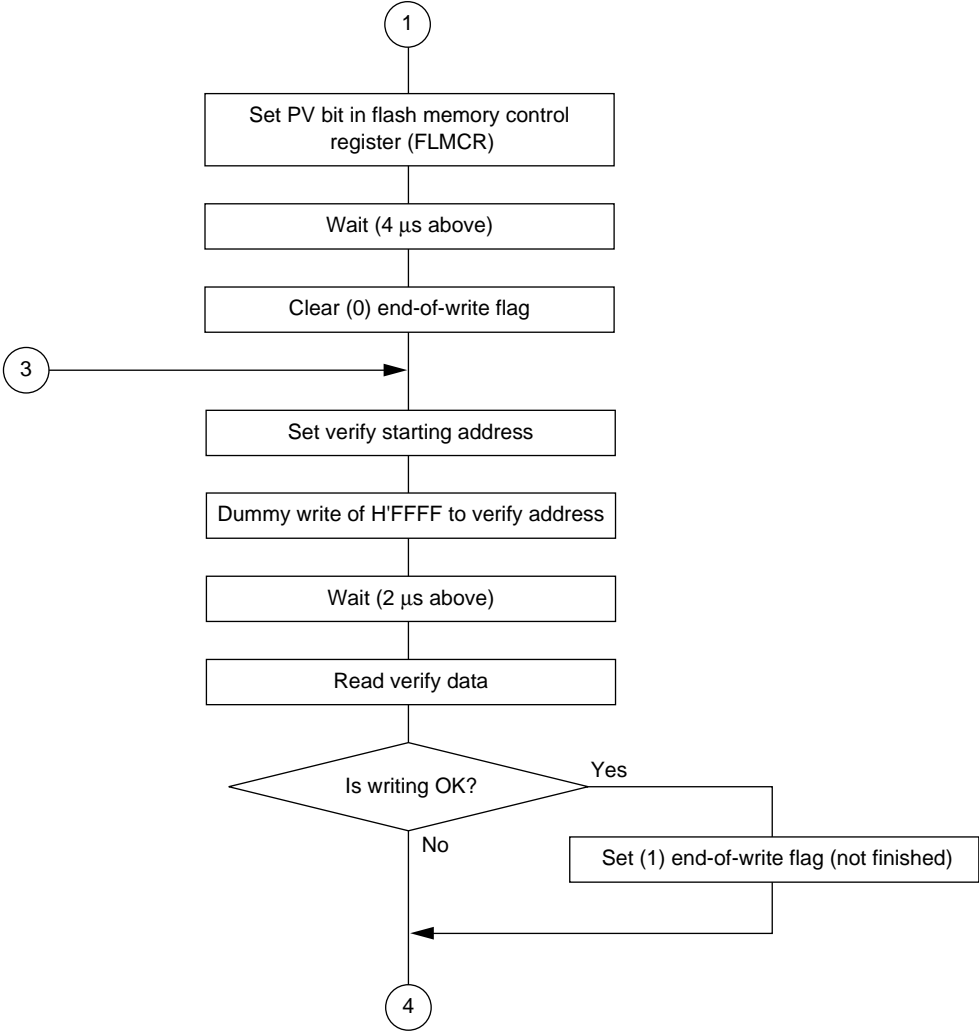
Flowchart Name	(7) Verify erasion of flash memory
Function	Verifies the erasion of the erased block area



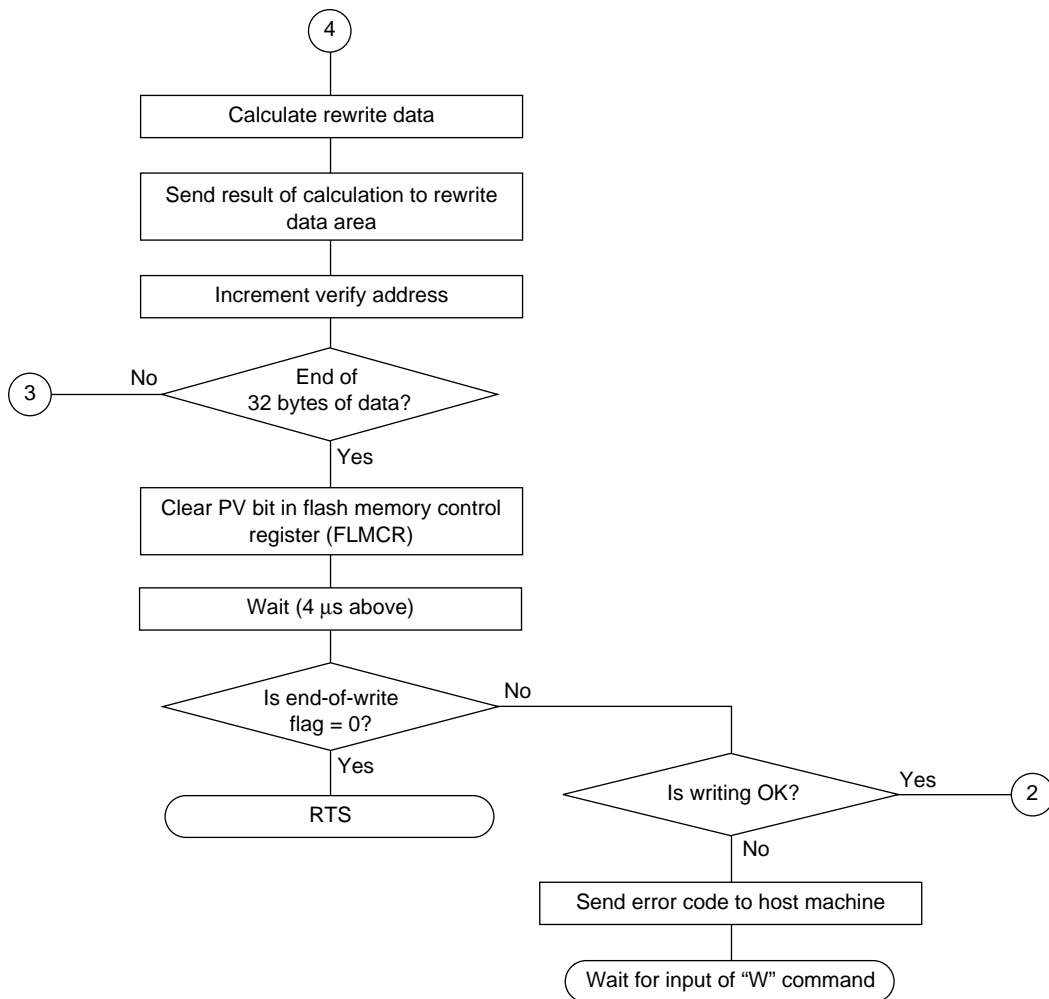
Flowchart Name	(8) Flash memory write-1
Function	Writes to flash memory



Flowchart Name	(8) Flash memory write-2
Function	Writes to flash memory



Flowchart Name	(8) Flash memory write-3
Function	Writes to flash memory



Section 3 On-Board Programming

This section describes how to install the on-board programming software, and how to use the boot mode and user program mode to transfer application programs from a host machine to a F-ZTAT microcomputer on a user system. For details of how to use the adapter board and on-board programming software described here, see the respective user's manuals.

3.1 Installing the On-Board Programming Software

1. Insert the floppy disk containing the on-board programming software into the disk drive of the PC.
2. Run SETUP.EXE on the floppy disk from Windows.
3. The message shown in Figure 3.1 is displayed on the screen. Click "OK" to start the installation process, or "Cancel" to abort installation.

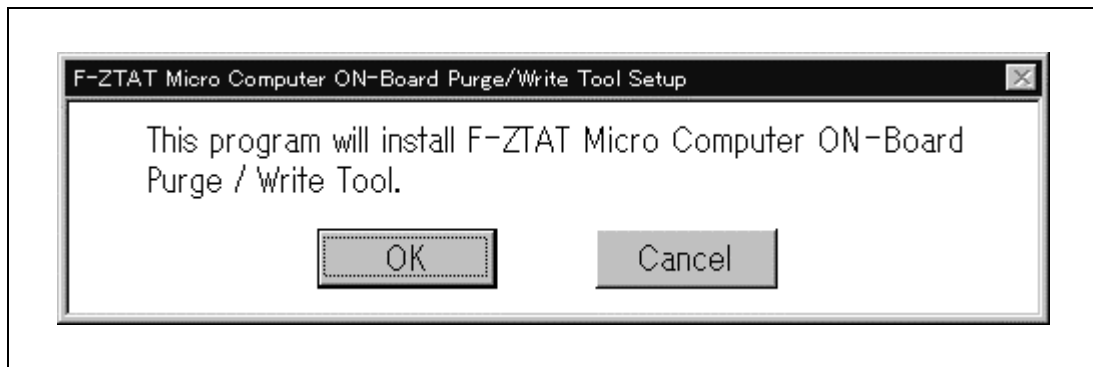


Figure 3.1 Installation Start Message

4. The installation dialog box shown in Figure 3.2 is displayed.

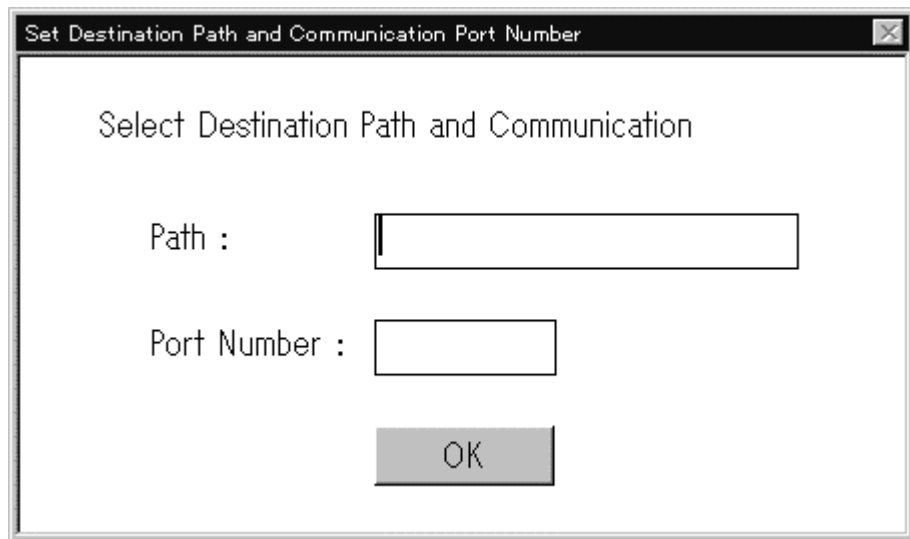


Figure 3.2 Installation Dialog Box

- (a) Enter the name of the installation directory in the “Directory” field. If you specify a directory that does not exist, the installation program makes that directory and copies the software to that directory.
- (b) Enter the number of the RS-232C port to be used to communicate with the user system in the “Port No.” field. The default port is Port 1 (COM1). Note that, if you are running this software on an NEC-9801, this setting is not required.
- (c) Click “OK” to copy the software to the directory specified in (a).

5. After the software has been copied to the directory, the message shown in Figure 3.3 is displayed on the screen. Click “OK” to register the FLASH group and the icon for this software in the program manager, and end the installation process. The registered icon is shown in Figure 3.4. You can also click “Cancel” to abort the installation process.

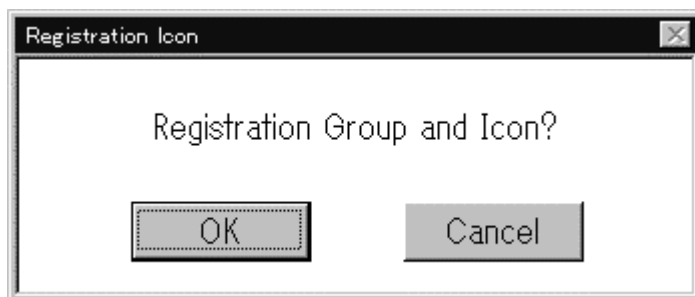


Figure 3.3 Installation Start Message



Figure 3.4 F-ZTAT Icon

3.2 On-Board Programming Sequence (Boot Mode)

Figure 3.5 shows the on-board programming sequence in boot mode. Section 3.3 describes the sequence in more detail.

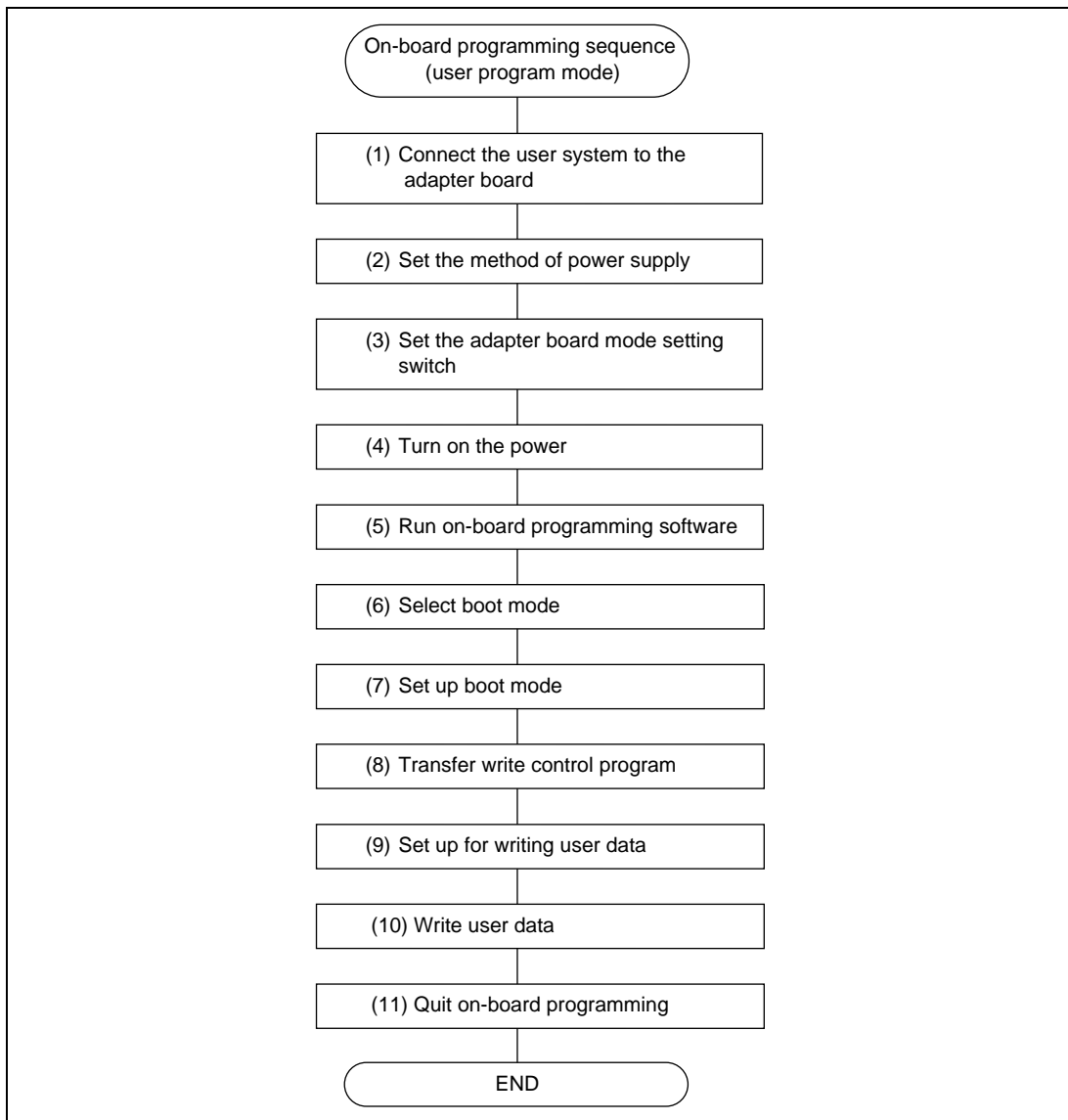


Figure 3.5 On-Board Programming Sequence (Boot Mode)

3.3 Writing in Boot Mode

Steps (1) to (11) below describe the process of writing in boot mode. This process uses the adapter board and on-board programming software.

(1) Connecting User System and Adapter Board

Connect the user system, adapter board, and host machine. See Section 2.1.6, “Connecting Adapter Board and User System” for details of how to connect the user system and adapter board.

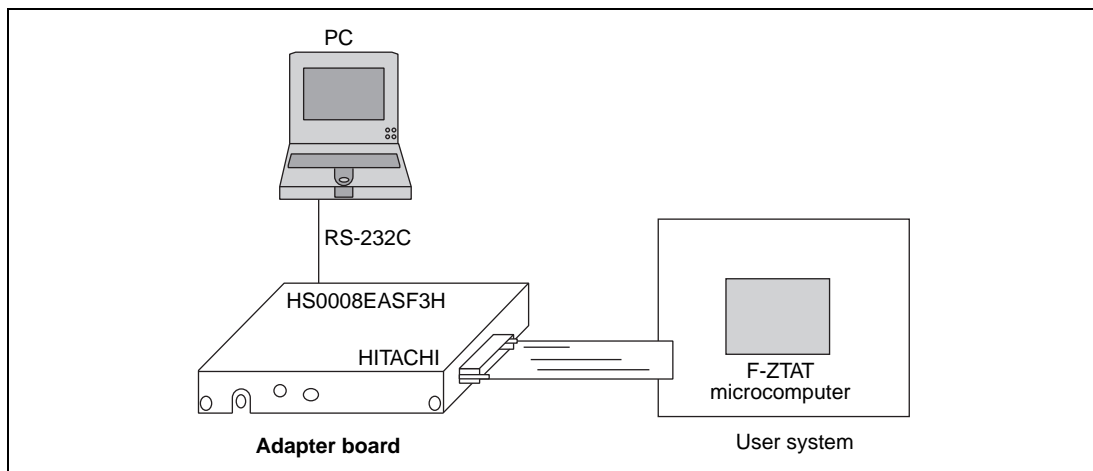


Figure 3.6 Connection of User System, Adapter Board, and Host Machine

(2) Setting Power Supply Method

Set the jumpers on the adapter board to select the power supply for the adapter board (user system or dedicated power supply [5VDC, etc.]). If you are supplying power from a dedicated power supply (5VDC, etc.), connect the power connector on the adapter board to a dedicated power supply (5VDC, etc.). Figure 3.7 shows the setup when supplying power from a general-purpose power supply.

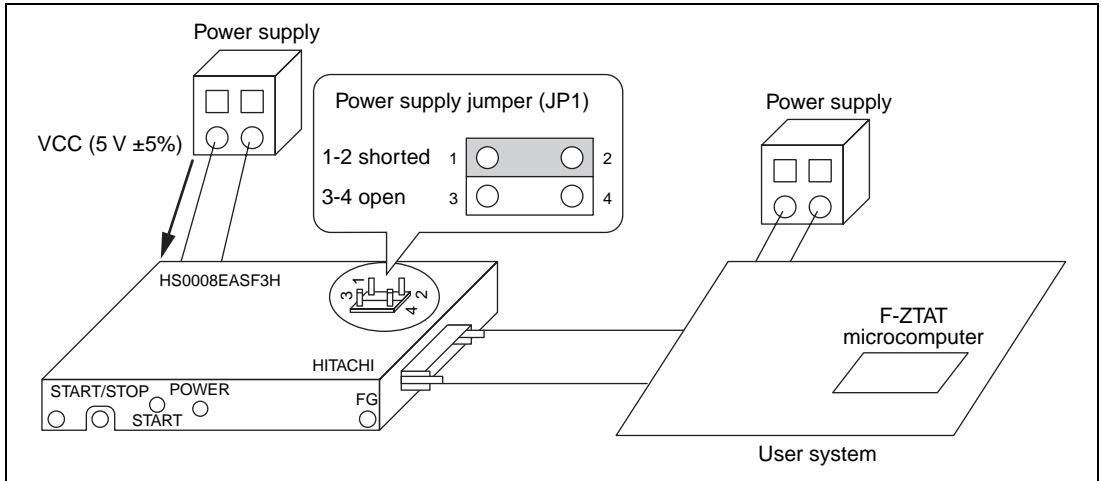



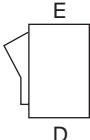
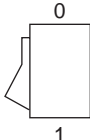
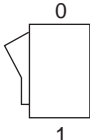
Figure 3.7 Setting Method of Adapter Board Power Supply

Note: When powering the adapter board from the user system, the adapter board has a current consumption of 500 mA (at 5 V) or 900 mA (at 3 V). If you are providing power from the user system, it is therefore important to ensure that the user system has adequate capacity to power the adapter board.

(3) Setting the Adapter Board Mode Setting Switch

Set the adapter board mode setting switch to boot mode. Boot mode is selected by setting the enable/disable switch (1) and the “0”/“1” switch (2) shown in Figure 2.3 to the settings shown in Table 3.1.

Table 3.1 Settings for Boot Mode

Switch No.	Control Signal	Enable/Disable Switch		0/1 Switch	
		Setting	Setting	0 Setting	1 Setting
1	FWE/FWP	Enabled	Disabled	Low	High
2	MD0	Enabled	Disabled	Low	High
3	MD1	Enabled	Disabled	Low	High
4	I/O0	Enabled	Disabled	Low	High
5	I/O1	Enabled	Disabled	Low	High
6	I/O2	Enabled	Disabled	Low	High
Switch position (side view)					

(4) Power Supply

Turn on the user system. Next, if you are supplying external power to the adapter board, turn on the POWER switch on the adapter board. When power is supplied to the adapter board, the POWER LED (green) lights on the adapter board (see (8) in Figure 2.2).

Note: With the above settings, the settings of the “0”/“1” switches 2, 4, 5, and 6 are “don’t care”. Connect the MD2 pin of the H8/3067F to the MD1 pin of the adapter board. Other settings for the F-ZTAT microcomputer are as shown in Table 2.4.

(5) Running the On-Board Programming Software

Run the on-board programming software on the host machine.

Double-click the FLASH icon in the FLASH group in the Program Manager to start the on-board programming software. When you start this software, the main window shown in Figure 3.8 is displayed, then the startup dialog box shown in Figure 3.9 is displayed.

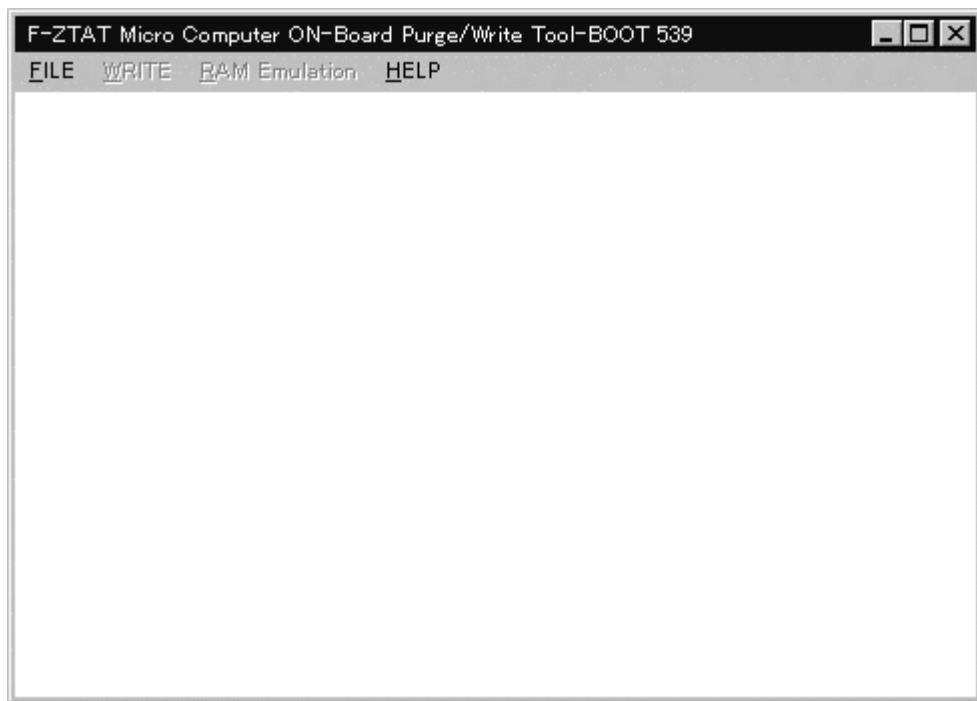


Figure 3.8 Main Window

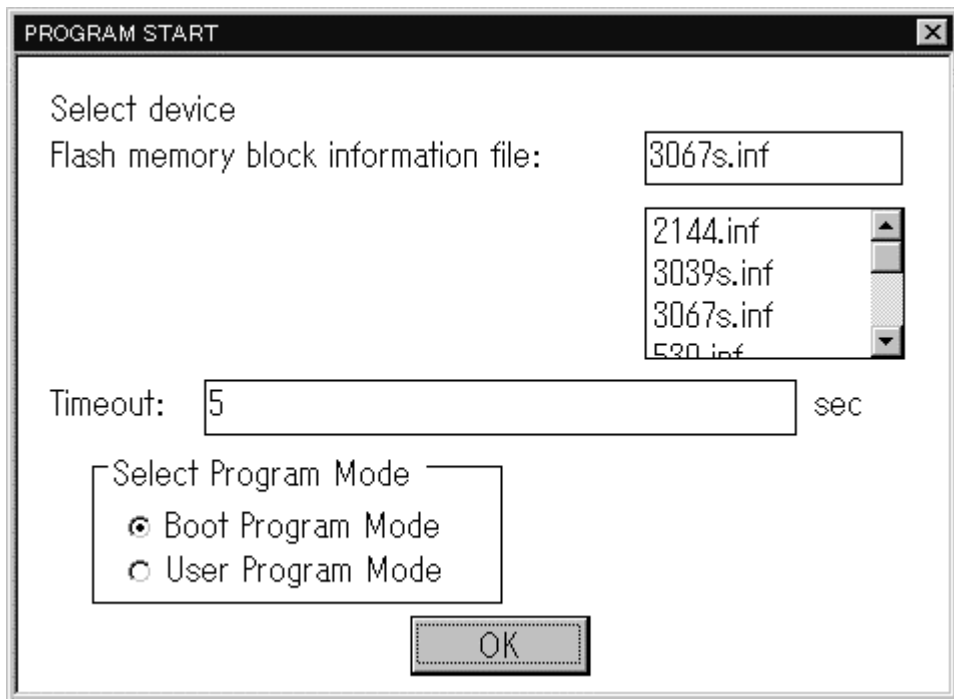


Figure 3.9 Startup Dialog Box

Description:

- (a) The "Flash memory block data file" field shows the flash memory block data files (*.INF) in the directory in which the on-board programming software is installed. Select the flash memory block data file to be used.
- (b) In the "Time-out time" field, specify the time-out time for detection of no response when communicating with the user system. The default time-out value is 5 sec. Enter a value in seconds if you wish to specify a different value.
- (c) In the "Mode selection" area, select the program mode. The default is Boot mode.

(6) Select Boot Mode

When you select boot mode in the startup dialog box shown in Figure 3.9, the boot mode dialog box shown in Figure 3.10 is displayed.

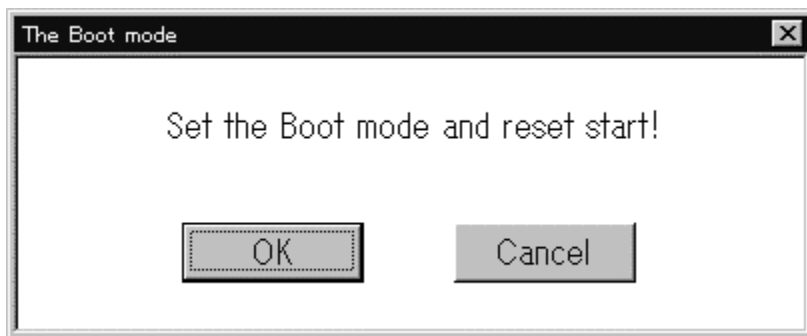


Figure 3.10 Boot Mode Dialog Box

(7) Setting Up Boot Mode

Set the switches as shown in Table 2.9, then press the START/STOP switch on the adapter board ((1) in Figure 3.11). The START LED turns ON.

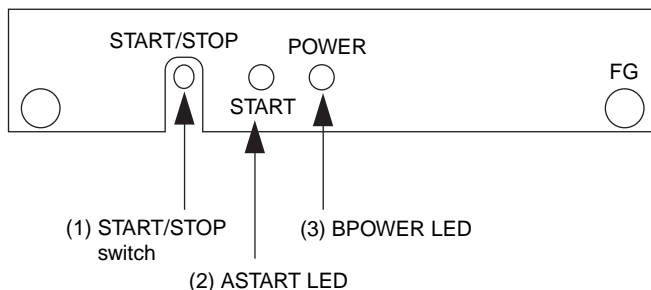


Figure 3.11 Boot Mode Settings

(8) Transferring the Write Control Program

When you click “OK” in the boot mode dialog box shown in Figure 3.10, the screen shown in Figure 3.12 is displayed and transfer of the write control program starts. The transfer status of the write control program is shown as a percentage. When 100% of the program has been transferred, the Main Window shown in Figure 3.8 is displayed.

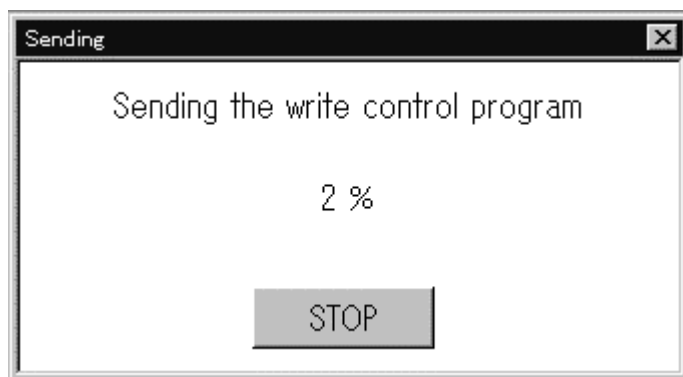


Figure 3.12 Dialog Box Displayed While Transferring Write Control Program

(9) Setting Up to Write User Data

Select “WRITE” from the menu shown in Figure 3.8 to display the screen shown in Figure 3.13. Click “OK” from the screen shown in Figure 3.13 to transfer user data without erasing a flash memory block.

You can also click “Cancel” to close the dialog box and return to the Main Window without erasing memory or transferring data.

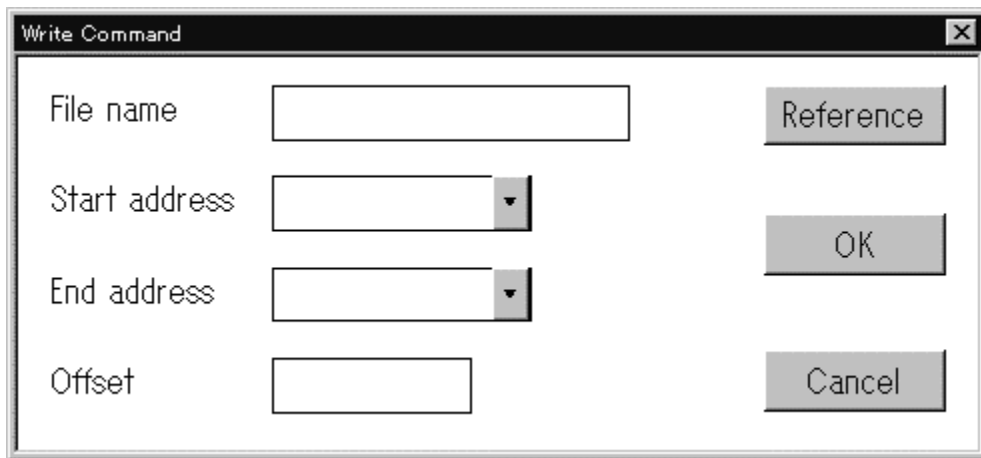


Figure 3.13 Write Command Dialog Box

Description:

- (a) Transfer user data to the F-ZTAT microcomputer. Specifying an address range transfers data only to the specified range in flash memory.
- (b) In the “Filename” field, specify the file containing the user data to be written to flash memory. If you do not know the name of the directory containing the file, click “Browse” to display the file selection dialog box and select the file to be written to flash memory.
- (c) In the “Starting address” field, specify the starting address at which data is to be written to flash memory. The default starting address is the start of flash memory.
- (d) In the “End address” field, specify the ending address for writing data to flash memory.
- (e) In the “Offset” field, specify the offset for the write address. Specify an offset if you want to change the write address without changing the load address for the user data. If you specify an offset, the offset is added to the load address for the user data when writing the data to flash memory. The default offset is “0”.

(10) Writing User Data

Click “OK” from the screen shown in Figure 3.13 to display the user data transfer dialog box shown in Figure 3.14 and start the transfer of user data. (Clicking “Cancel” in Figure 3.14 aborts the data transfer and closes the dialog box. Execution returns to the Main Window.)



Figure 3.14 Flash Memory User Program Transfer Dialog Box

(11) Ending the On-Board Programming Process

Pressing the START/STOP switch on the front of the adapter board ((1) in Figure 3.15) turns off the START LED (red). You can now end the programming process, remove the adapter board, and check that the newly written program runs correctly.

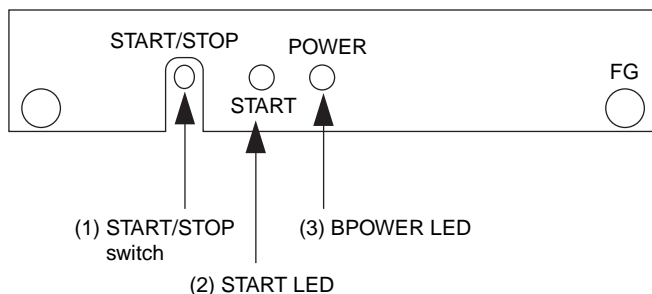


Figure 3.15 Ending the Writing Process

3.4 On-Board Programming Sequence (User Program Mode)

Figure 3.16 shows the on-board programming sequence in user program mode. Section 3.5 describes the sequence in more detail.

On-board programming sequence (user program mode)

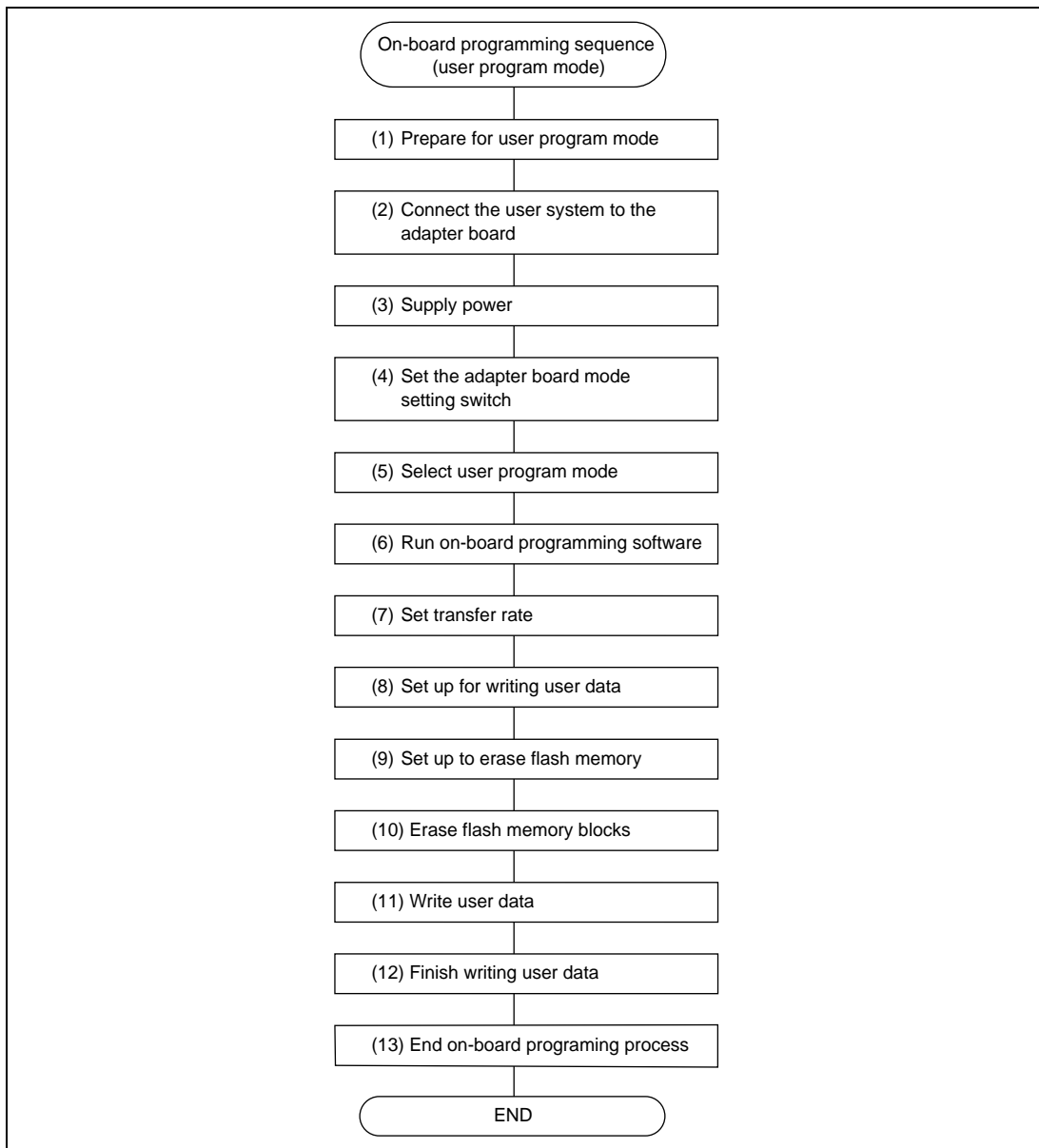


Figure 3.16 On-Board Programming Sequence (User Program Mode)

3.5 Writing in User Program Mode

Steps (1) to (13) below describe the process of writing in user program mode. This process uses the on-board programming adapter board and on-board programming software.

(1) Preparing for user program mode

To use user program mode, the programs shown in Figure 3.17 must first be written in boot mode or using a PROM programmer as part of the application program. The processes of the programs shown in Figure 3.17 are described according to the steps shown in Figure 3.18, “User Program Mode Startup Sequence”.

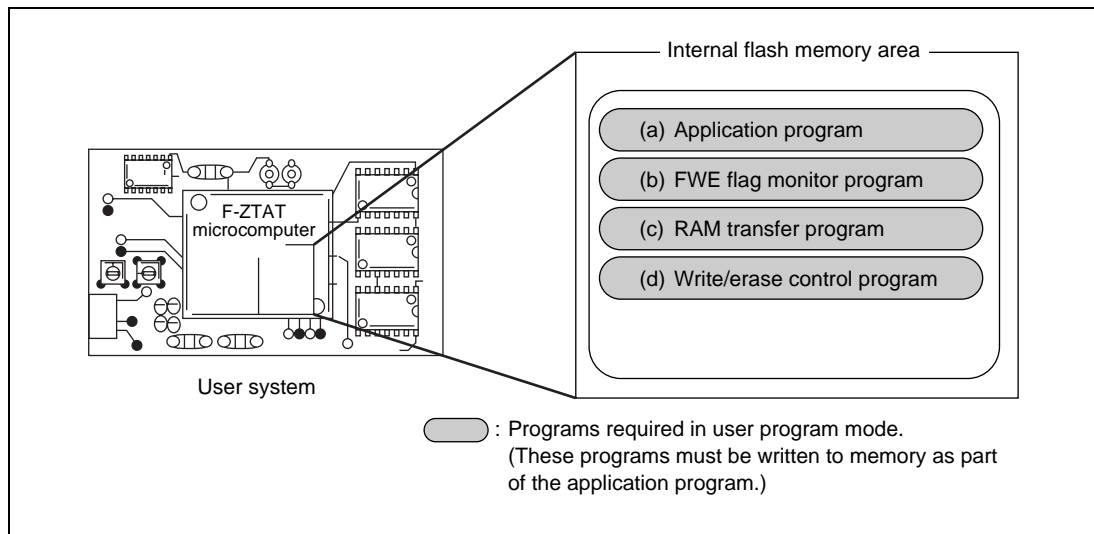


Figure 3.17 Programs Required in User Program Mode

Description:

(a) Application program

Program controlling the user system (This program is prepared by the user.)

(b) FWE flag monitor program

This program monitors the FWE flag (FWE pin enable) in the flash memory control register (FLAMCR). (This program is prepared by the user.)

(c) RAM transfer program

This program transfers the write/erase control program to RAM when user program mode starts. (This program is prepared by the user.)

(d) Write/erase control program

In user program mode, this program is run in RAM and controls the reception of the application program and the writing to and erasing of flash memory.

(Use the write/erase control program in the on-board programming software.)

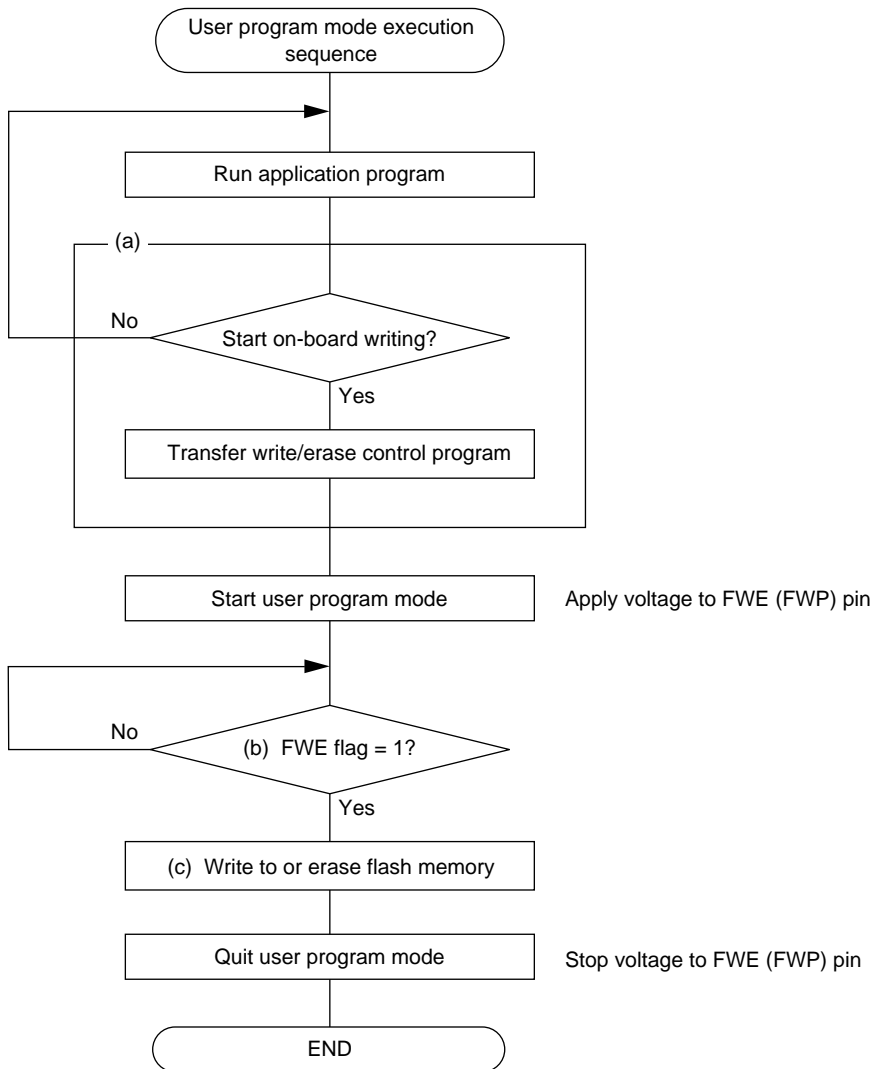


Figure 3.18 User Program Mode Startup Sequence

Description:

- (a) The on-board programming start monitor program monitors the trigger signal for starting on-board programming. When performing on-board programming, start the RAM transfer program, which transfers the write/erase control program in the on-board programming software already written to flash memory to RAM, then runs the write/erase control program from RAM.
- (b) The FWE flag monitor program monitors the FWE flag in the flash memory control register (FLMCR). When the FWE flag = 1 (FWE pin = 1), the user program mode starts.
- (c) The write/erase control program erases the flash memory block to which the application program is to be written, then writes the application program received from the host machine to flash memory. After the application program has been written to memory, it is run.

Note: Writing write/erase control program to flash memory

The write/erase control program in the on-board programming software runs in the internal RAM of the F-ZTAT microcomputer (the RAM area to which the write control program is transferred in boot mode).

When transferring the write/erase program in the on-board programming software before entering user program mode, set the address within the RAM area of the F-ZTAT microcomputer (the RAM area to which the write/erase program is transferred in boot mode).

When using the on-board programming software to write the write/erase control program to flash memory, you must specify the offset (to change the write address to the address in flash memory). See Section 3.5 (8) for how to specify the offset.

(2) Connecting user system and adapter board

Connect the user system, adapter board, and host machine. See Section 3.1, “Preparing for On-Board Programming” for details of how to connect the user system and adapter board.

(3) Supplying power

Turn on the user system. Next, if you are supplying external power to the adapter board, turn on the POWER switch on the adapter board. When power is supplied to the adapter board, the POWER LED (green) lights on the adapter board.

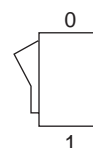
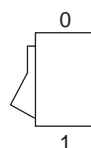
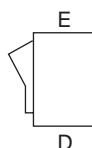
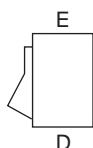
(4) Setting the adapter board mode setting switch

Set the adapter board mode setting switch to user program mode. User program mode is selected by setting switches (1) and (2) in Figure 2.3 to the settings shown in Table 3.2.

Table 3.2 Settings for User Program Mode

Switch No.	Control Signal	Enable/Disable Switch		0/1 Switch	
		Enable Setting	Disable Setting	0 Setting	1 Setting
1	FWE/FWP	Enabled	Disabled	Low	High
2	MD0	Enabled	Disabled	Low	High
3	MD1	Enabled	Disabled	Low	High
4	I/O0	Enabled	Disabled	Low	High
5	I/O1	Enabled	Disabled	Low	High
6	I/O2	Enabled	Disabled	Low	High

Switch position
(side view)



Note: With the above settings, the settings of switches 2 to 6 ("0"/"1" switches) are "don't care".
See Table 2.4 for other F-ZTAT microcomputer settings.

(5) Setting up for user program mode

Set the switches shown in Table 2.10, then press the START/STOP switch on the adapter board ((1) in Figure 3.11). The START LED lights and user program mode starts.

(6) Running the on-board programming software

Run the on-board programming software on the host machine.

Select “MODE” from the menu in the window shown in Figure 3.8 to display the startup dialog box shown in Figure 3.19. Select user program mode.

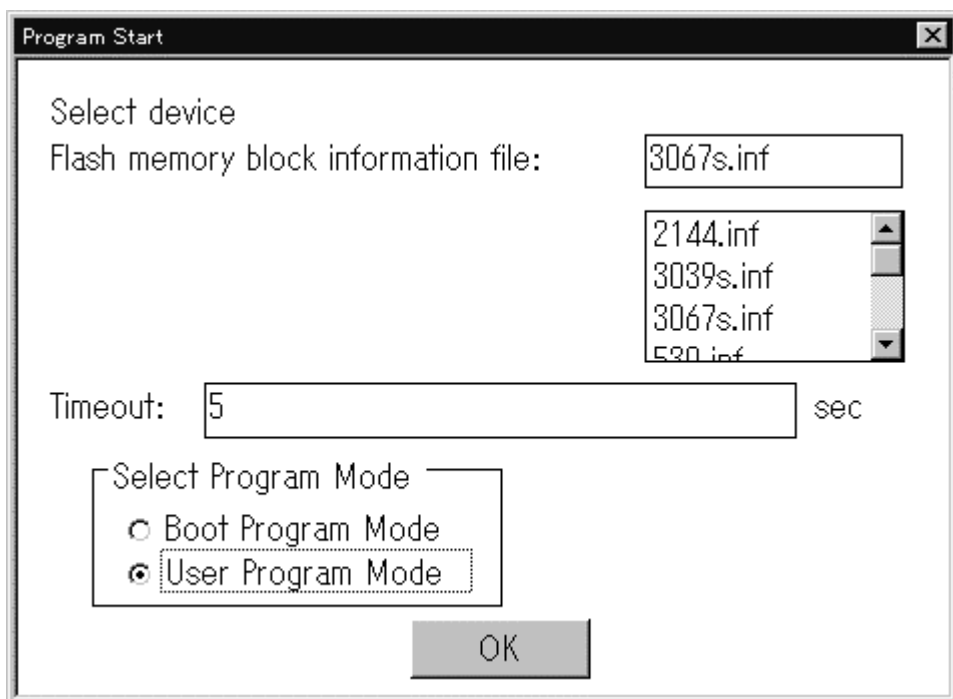


Figure 3.19 Startup Dialog Box

(7) Setting transfer rate

After selecting user program mode, display the transfer rate setting as shown in Figure 3.20. Set the transfer rate to the host machine's setting. Set the F-ZTAT microcomputer transfer rate (SCI channel 1) using the RAM transfer program or write/erase control program.

Note that the host machine can be set for the following transfer rates: 38400, 19200, 9600, 4800, and 2400 bps.

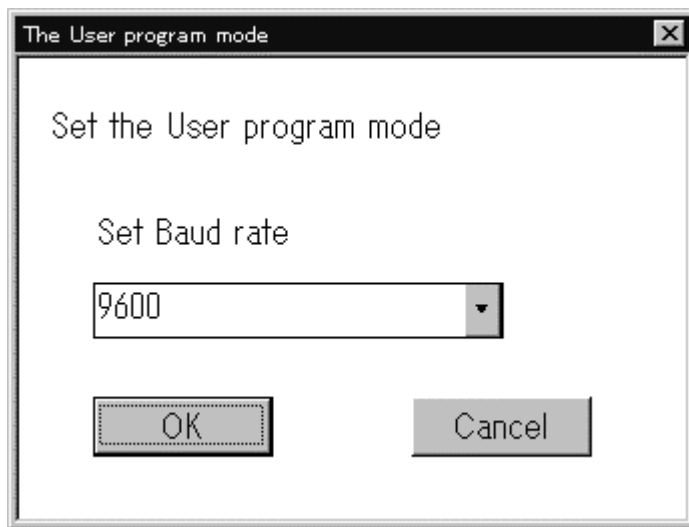


Figure 3.20 User Program Mode Transfer Rate Dialog Box

(8) Setting up for writing user data

Figure 3.21 shows an example of a dialog box for write commands for extracting addresses 0xF000 to 0xFFFF from the user data to transfer to 0x10000 to 0x100FF only. In this example, application program TEST.MOT is written to flash memory.

For details of writing in boot mode, see Section 3.2, “Writing in Boot Mode”. Here, the write address for the write/erase control program is changed to address H'10000 in flash memory. Set the address as a 32-bit hexadecimal value.

Calculation example: $H'F000 + \text{offset} = H'000010000$

Offset = $H'00010000$ to $H'0000F000 = H'00001000$

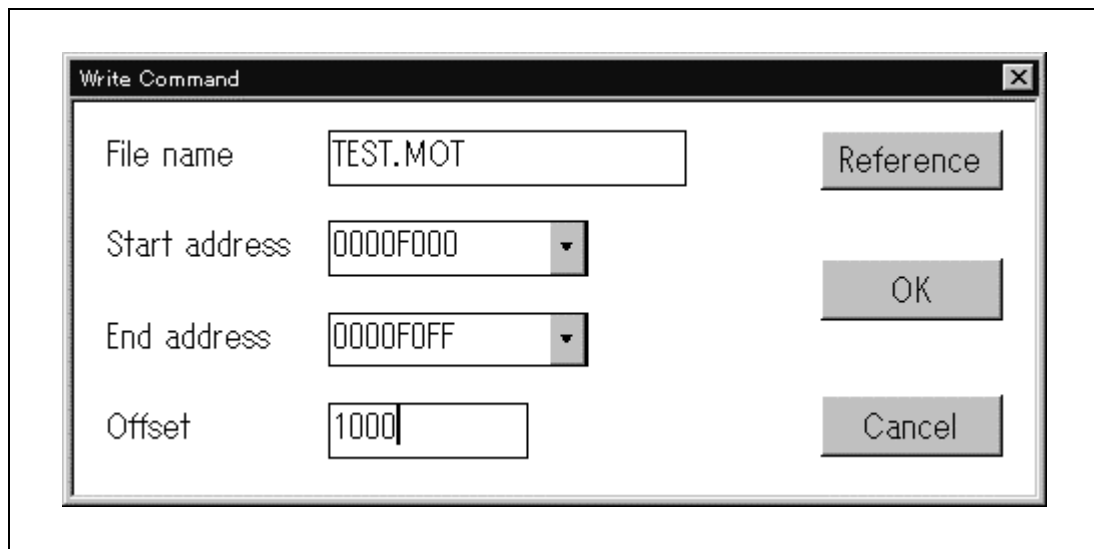


Figure 3.21 Example Write Command Dialog Box

- (a) Before transferring the user data to the F-ZTAT microcomputer, check whether to erase the pertinent block in flash memory. (This is necessary only in user program mode.)
- (b) If erasing flash memory, erase the pertinent block in flash memory, then transfer the user data.

(9) Setting up to erase flash memory

Click “OK” in Figure 3.21 to display the dialog box for specifying the flash memory block for erasure shown in Figure 3.22.

You can click “Cancel” to close the dialog box and return to the Main Window without erasing memory or transferring data.

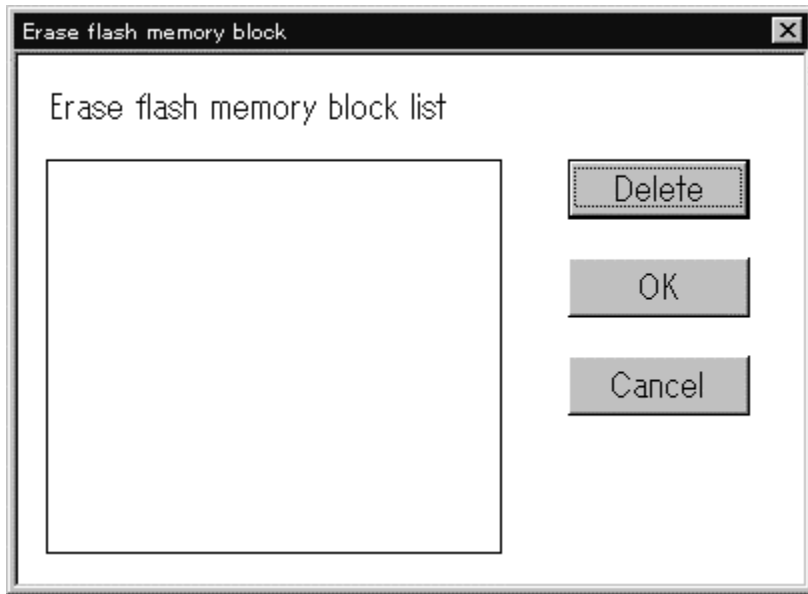


Figure 3.22 Flash Memory Erasure Specification Dialog Box

- (a) The “Erase flash memory block” field shows the flash memory block containing user data. This is the target flash memory block to be erased.
- (b) If there are any flash memory blocks that you do not wish to erase, click any pertinent blocks displayed in the “Erase flash memory block” field with the mouse, then click “Exclude”.

(10) Erasing flash memory blocks

Click “OK” in the Flash Memory Erasure Specification Dialog Box shown in Figure 3.22 to display the Erasing Flash Memory Blocks dialog box shown in Figure 3.23 and start erasing the flash memory blocks. You can also click “Cancel” to close the dialog box and return to the Main Window without erasing the flash memory blocks.

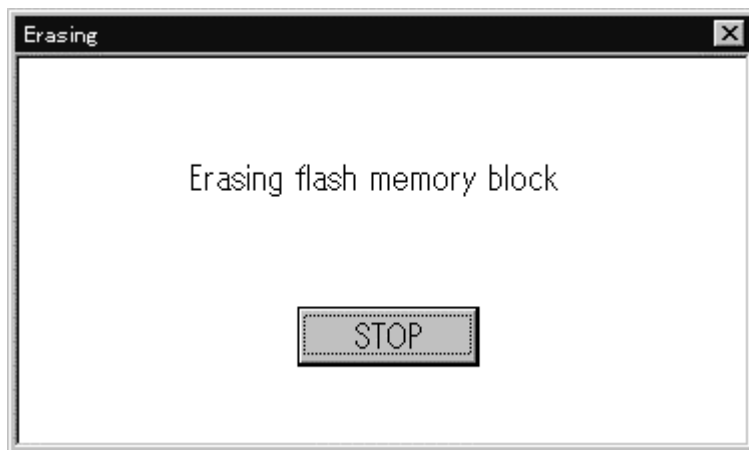


Figure 3.23 Erasing Flash Memory Blocks Dialog Box

(11) Writing user data

After erasing the flash memory blocks, the Transferring User Data dialog box shown in Figure 3.24 is displayed. When the display reaches 100%, the transfer of user data ends. (You can click “Cancel” in the dialog box shown in Figure 3.23 to stop erasing, close the dialog box, and return to the Main Window.)



Figure 3.24 Transferring User Program Dialog Box

(12) Ending writing of user data

After the user data has been transferred and writing to flash memory is completed without error, the Transferring User Data dialog box closes. (Clicking “Cancel” stops the transfer of user data, closes the dialog box, and returns execution to the Main Window.)

(13) Ending the on-board programming process

Pressing the START/STOP switch on the front of the adapter board ((1) in Figure 3.15) turns off the START LED (red). You can now end the writing process, remove the adapter board, and check that the newly written program runs correctly.

Section 4 Example Use of User System

4.1 Example Switching Circuit

4.1.1 Example SCI Switching Circuit

When performing on-board programming in boot mode, the boot program built into the F-ZTAT microcomputer uses SCI channel 1 (TXD1 and RXD1) to interface with the PC. Therefore, if the user system uses SCI1, the user system must switch between its own use of SCI1 and the use of SCI1 for on-board programming. In user program mode, too, SCI1 must also be switched if using the Hitachi on-board programming tool.

Table 4.1 shows example SCI1 switching circuits for the H8/3067F, SH7044F, and H8S/2144F. The circuits shown in Table 4.1 detect the levels of the write control signals of the respective F-ZTAT microcomputers and switch SCI1 between the user system and for writing.

Table 4.1 Example SCI1 Switching Circuits for Representative F-ZTAT Microcomputers

Device	Example Circuit	Description of Operation
H8/3067F		<p>Switches SCI1 usage according to level of FWE pin.</p> <ol style="list-style-type: none"> 1. FWE = High (boot mode or user program mode) Sets SCI1 for writing. 2. FWE = Low (normal operation) Sets SCI1 for user system. <p>Normal operation: When running user application program in internal flash memory.</p>
SH7044F		<p>Switches SCI1 usage according to level of FWP pin.</p> <ol style="list-style-type: none"> 1. FWP = Low (boot mode or user program mode) Sets SCI1 for writing. 2. FWP = High (normal operation) Sets SCI1 for user system.
H8S/2144F		<p>Switches SCI1 usage according to level of MD0 pin and I/O pin.</p> <ol style="list-style-type: none"> 1. MD0 = Low (boot mode) or I/O = Low (user program mode) Sets SCI1 for writing. 2. MD0 = High and I/O = High (normal operation) Sets SCI1 for user system. <p>*: I/O ports: don't care</p>

Notes: The example H8S/2144F switching circuit in Table 4.1 is based on the conditions shown below.

- Boot mode
If MD0 = Low, SCI1 is used for writing. (When the H8S/2144F is in boot mode, MD0 and MD1 = Low and P90 to P92 = High.)
- User program mode
In user program mode, the I/O port is controlled and selects the SCI1 usage by the user application program. The example circuit shown in Table 4.1 shows an example of switching the SCI1 for writing by outputting a Low level from the I/O port.

4.1.2 Example I/O Port Switching Circuit

When writing with the H8S/2144F in boot mode, P90 to P92 must be set High. Therefore, if the user system uses P90 to P92 as input ports, the user system must switch the usage of these ports between its own usage and their use as boot mode setting pins. If they are used as output ports, P90 to P92 must be pulled up on the user system.

Table 4.2 shows example I/O port switching circuits. In these examples, P90 to P92 are set High by the user system without their being connected to I/O0 to I/O2 on the adapter board. In the example circuits for using P90 to P92 as input ports, P90 to P92 are set High if MD0 is Low. (To reset and start boot mode, MD0 and MD1 are set Low and P90 to P92 are set High.) In the example circuits for using P90 to P92 as output ports, P90 to P92 must be pulled up and set High.

Table 4.2 Example I/O Port Switching Circuits

Target Use of P90 to P92	Example Circuit	Description of Operation
Used as input ports by user system		<p>Switches the target use of P90 to P92 according to level of MD0 pin.</p> <ol style="list-style-type: none"> MD0 = High (normal operation) P90 to P92 used as input ports. MD0 = Low (boot mode) P90 to P92 used as boot mode setting pins. P90 to P92 = High.
Used as output ports by user system		<ol style="list-style-type: none"> Normal operation P90 to P92 used as output ports. Boot mode P90 to P92 used as boot mode setting pins. P90 to P92 = High

Note: The sample circuit above is for the case where the H8S/2144F is used in mode 3 in normal operation. If using the H8S/2144F in mode 2 in normal operation, monitor the state of the MD1 pin and switch the usage of P90 to P92.

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